

APPENDIX B

AIR QUALITY

This appendix provides supplemental information regarding the air quality analyses presented in chapter 5. This appendix addresses aspects of both radiological air emissions and nonradiological air emissions.

B.1 RADIOLOGICAL AIR QUALITY

B.1.1 Methodology

The radiological air quality analyses address:

- *Facility-Specific Maximally Exposed Individual (FS MEI)*—The FS MEI represents a location near a facility that is modeled as having the greatest dose to a hypothetical public individual from all modeled emissions under a given SWEIS alternative.
- *LANL Site-Wide Maximally Exposed Individual*—The LANL MEI represents the location of the single highest modeled dose to a hypothetical public individual. Under a given alternative, the highest FS MEI becomes the LANL MEI for that alternative.
- Collective dose to the population within a 50-mile (80-kilometer) radius from LANL.

In addition to these receptors, isodose maps were developed that show the estimated committed effective dose equivalents (CEDEs) at any location within the 50-mile (80-kilometer) radius. These maps were developed to allow individuals within the 50-mile (80-kilometer) radius to estimate their modeled CEDE.

In order to enable these analyses, a review of historical emissions was undertaken for the period 1990 through 1994. The data were largely derived from past National Emission Standards for Hazardous Air Pollutants

(NESHAP) reports. The data reviewed are summarized in Table B.1.1–1. The data show the CEDE to the LANL MEI. Although valid, these data were only available for the LANL MEI, not for the FS MEI.

MEIs are hypothetical individuals who do not leave and do not take protective actions to avoid exposure. The risk from ionizing radiation consists mostly of some number of excess latent cancer fatalities (LCFs). These are cancers resulting from, and that develop well after, the exposure to ionizing radiation. These represent an increase in the number of fatal cancers that occur from other causes. The excess LCF is the product of the dose and the risk factor of 5×10^{-4} excess LCF per person-rem. The reader should recognize that these estimates are intended to provide a conservative measure of the potential impacts to be used in the decision-making process and do not necessarily portray an accurate representation of actual anticipated fatalities. In other words, one could expect that the stated impacts form an upper bound and that actual consequences could be less, but probably would not be worse. This is discussed in the primer on the effects of radiation in section D.1 of appendix D, Human Health.

B.1.1.1 Modeled Facilities

Several facilities at LANL emit radioactive materials to the ambient air through stacks, vents, or diffuse emissions. Not all of the facilities listed in Table B.1.1–1 were modeled for this SWEIS. Those facilities not modeled were eliminated from such detailed analysis because they have historically low emission rates or because they are not expected to operate during the period analyzed in the SWEIS. The facilities modeled include 16 emission points from 12 facilities within 10 TAs. These facilities are listed in Table B.1.1.1–1. These

TABLE B.1.1-1.—Historical Summary of Dose Estimates to LANL's Maximally Exposed Individual from Radioactive Air Emissions (1990 Through 1994)

MODELED EFFECTIVE DOSE EQUIVALENT (mrem/yr) TO LANL'S MEI FROM AIRBORNE RELEASES						
	1990 ^a	1991 ^a	1992	1993	1994	AVERAGE ^b
						PERCENT
EDE (mrem/yr) from point and nonpoint sources	15.3	6.5	7.9	5.6	7.6	7.33
POINT SOURCES						
LA-1:TA-2 (Omega West Reactor)	NA	NA	0.0061	0.000061	0.0000255	0.00206
TA-41 (Weapons Material Fabrication)						0.028
LA-2: TA-3 (CMR Laboratory, Van de Graff)	NA	NA	0.00164	0.00277	0.00188	0.00210
LA-4:TA-33 (Old Tritium Handling Facility)	NA	NA	9.00 x 10 ⁻⁶	0.0000100	0.000014	0.0000110
LA-5:TA-21, TA-35, TA-43, TA-48, TA-50, TA-55	NA	NA	0.0012	0.0244	0.0173	0.0176
LA-5a:TA-21					0.0167	0.241
LA-5b:TA-35, TA-50, TA-55					0.0000528	
LA-5c:TA-43					4.11 x 10 ⁻⁶	
LA-5d:TA-48					0.000528	
LA-6:TA-53 (LANSCE)	NA	NA	7.83	4.57	6.74	6.38
LA-7:TA-54 (Waste Disposal Site)	NA	NA	4.08 x 10 ⁻⁸	0	6.54 x 10 ⁻⁸	3.54 x 10 ⁻⁸
Total Point Source			7.85	4.597	6.78	6.40
NONPOINT SOURCES						
LA-3:TA-15 (PHERMEX), TA-36 (Open-Air Explosive Tests Sites)	NA	NA	0.009	0.066	0.16	0.030
LA-8:TA-54 (Active Storage and Disposal Site)	NA	NA	NA	0.0007	0.0000540	0.0000610
LA-9:TA-6, TA-21, TA-33, TA-49, TA-54 (Inactive Storage and Disposal Sites)	NA	NA	NA	NA	NA	0.001
LA-11:TA-14, TA-15, TA-36, TA-39 (Residual Materials at Inactive Firing Sites)	NA	NA	NA	NA	NA	

TABLE B.1.1-1.—Historical Summary of Dose Estimates to LANL's Maximally Exposed Individual from Radioactive Air Emissions (1990 Through 1994)-Continued

MODELED EFFECTIVE DOSE EQUIVALENT (mrem/yr) TO LANL'S MEI FROM AIRBORNE RELEASES						
	1990 ^a	1991 ^a	1992	1993	1994	AVERAGE ^b
LA-12:TA-53 (Effluent Release to Holding Ponds)	NA	NA	0.00083	1.90×10^{-7}	0.0088	0.003
LA-13:TA-53 (Residual Radionuclides in Ponds)	NA	NA	NA	NA	NA	0.044
LA-14: TA-50 (Liquid Release to Canyon)	NA	NA	0.00014	0.00210	1.80×10^{-7}	0.001
LA-15:TA-2, TA-41, TA-45, TA-50 (Residual Radionuclides in Canyon)	NA	NA	NA	NA	NA	0.01
LA-16:TA-53 (Fugitive Emissions)	NA	NA	NA	1.0	0.8	0.900
LA-17:TA-21, TA-33 (Fugitive Emissions from Decontamination and Decommissioning Facilities)	NA	NA	NA	0.014	NA	12.28
Total from Nonpoint Sources			0.00997	1.07	0.82	0.934
						12.7

Notes:

NA = Not available (data were not available for that site that year), LANSCE = Los Alamos Neutron Science Center, PHERMEX = Pulsed High-Energy Radiation Machine Emitting X-Ray Facility

^a The effective dose equivalent to the LANL MEI was not reported from individual facilities in 1990 and 1991. The only value reported in those years was the total dose (from all facilities combined) to the LANL MEI.

^b Because the detailed individual source contributions are not available for 1990 and 1991, this average has been calculated for the 3-year period from 1992 to 1994.

TABLE B.1.1.1-1.—List of Facilities Modeled for Radionuclide Air Emissions from LANL

FACILITIES	
TA-3-29	CMR Building
TA-3-66	Sigma Building
TA-3-102	Machine Shops
TA-11	High Explosives (HE) Testing
TA-15/36	Firing Sites
TA-16	WETF
TA-18	Pajarito Site: LACEF
TA-21	TSTA and TSFF
TA-48	Radiochemistry Laboratory
TA-53	LANSCE ^a
TA-54	Area G
TA-55	Plutonium Facility

Notes:

^a Five specific sources were modeled from TA-53. These include the TA-53 Exhaust Stack-2 (ES-2), Exhaust Stack-3 (ES-3), Isotope Production Facility (IPF), Low-Energy Demonstration Accelerator (LEDA), and combined diffuse emissions.

CMR = Chemistry and Metallurgy Research, WETF = Weapons Engineering Tritium Facility, LACEF = Los Alamos Critical Experiments Facility, TSTA = Tritium System Test Assembly, TSFF = Tritium Science Fabrication Facility

facilities historically have emitted the majority of radioactive materials to the air or were affected by the SWEIS alternatives.

Emission projections were made by alternative for each of these facilities. These estimates were based on historical activity levels and emissions and the SWEIS alternative descriptions. These estimates served as the basis for modeling the consequences of LANL radiological air emissions.

B.1.1.2 Selection of the CAP-88 Model

Based on estimated emission rates under various alternatives, air dispersion modeling was performed to evaluate the radiation doses

(CEDEs) from these emissions. The *Clean Air Act* Assessment Package-1988 (CAP-88) (EPA 1992a) is one such air dispersion model. It was selected to perform dose calculations. CAP-88 contains a modified Gaussian plume model that estimates the average dispersion of radionuclides released from up to six sources simultaneously. The model may be run on individual sources as well. The sources may be elevated stacks or uniform area (diffuse) sources. The program computes radionuclide concentrations in air, rates of deposition on ground surfaces, concentrations in food from radionuclides emitted to the air, and intake rates for people from ingestion of food produced in the assessment area. The model calculates the CEDE resulting from these air emissions and resulting exposure pathways.

CAP-88 was chosen for the following reasons:

- CAP-88 is approved by the U.S. Environmental Protection Agency (EPA) for demonstrating compliance with the NESHAP (40 Code of Federal Regulations [CFR] 61, Subpart H) and is used by LANL and other DOE facilities for that purpose. Consequently, DOE and LANL have experience with this code, and it is acceptable to other regulatory agencies.
- CAP-88 is known to compare favorably with other models for producing results that generally agree with experimental data.
- To support NESHAP estimates, the LANL mainframe version of CAP-88 was previously modified to include special radionuclides emitted by the Los Alamos Neutron Science Center (LANSCE). Those radionuclides are mainly activation products that are not modeled by the personal computer version or by other air dispersion models, such as the Generation II (GENII) model prepared for DOE by Pacific Northwest Laboratory.
- CAP-88 adequately accounts for both point sources and diffuse sources, which are both present at LANL.

- Other models (such as GENII) do not have any significant advantages over CAP-88 that would negate its use.

B.1.1.3 *Limitations of the CAP-88 Model*

As in all computer models, there are some limitations in the CAP-88 model. These limitations were considered prior to the use of this model but were dismissed. The most important limitations are described below.

- While up to six sources can be modeled in a single run, all the sources are assumed to be at the same geographic point during the modeling run. This was overcome by performing separate model runs for each source.
- CAP-88 assumes a flat terrain during the radionuclide transport. Complex terrain cannot be modeled by CAP-88. This effect was considered negligible when the distance to the exposed individuals is large compared to the stack height, area, or facility size. The flat terrain model is customary and used elsewhere to model LANL emissions.
- The model assumes that individuals remain at locations 24 hours a day, 365 days a year, when estimating the dose for that specific location. This is obviously unlikely but provides worst-case bounding conditions.
- CAP-88 calculates the dose from external radiation from radionuclides in the air that envelops the receptor. However, if the radionuclide cloud is only overhead and not in touch with the ground, the radiation dose is not calculated. This is not regarded as a serious shortcoming because of the absorption of the radiation in air and CAP-88's overestimate of the dose once the cloud has touched down. In most past years, environmental monitors have shown lower exposures than were calculated using CAP-88.

B.1.1.4 *Model Input Parameters*

The CAP-88 model requires many input parameters in order to perform dose calculations. Most of these parameters are built into the model and require no input from the user. However, some parameters (such as the amount of radionuclide emitted) must be introduced by the user. These user-defined inputs are discussed below, along with how the data were derived.

Radionuclide Emission Rate Data

Radionuclide emission rate projections for each alternative were introduced into the CAP-88 model. Some modeled facilities have more than one emission point, depending on the operations within the facilities. For example, TA-53 has five emission points, which were modeled separately. The radionuclides emitted and their modeled emission rates for each facility are summarized in Tables B.1.1.4-1 through B.1.1.4-17.

All radionuclide emissions were modeled using the personal computer version of CAP-88, except when the radionuclides contain mixed activation products (MAPs). In those cases, the LANL mainframe version of CAP-88 was used for modeling. The only two modeled facilities that required the use of LANL mainframe computers were TA-48 and TA-53.

Some assumptions had to be made while modeling some radionuclide emissions from LANL. In all cases, the most conservative assumption was selected for use, resulting in an overestimation of the committed effective dose equivalents. These assumptions are:

- Actinide and particulate emissions from the Chemistry and Metallurgy
- Research (CMR) Building and TA-55 were not modeled by radionuclide. All actinide and particulate emissions from these facilities were assumed to be plutonium-239.

TABLE B.1.1.4–1.—Radiological Air Emissions from TA–3–29 (CMR)

STACK NUMBER	WING 2	WING 4	WING 9
	ES–14	ES–24	ES–46
STACK PARAMETERS			
Height (meters)	15.9	15.9	21.5
Diameter (meters)	1.1	1.1	2.1
Exit Velocity (meters per second)	6.8	14.6	1.9
EMISSION RATE PER STACK (CURIES PER YEAR)			
No Action Alternative			
Actinides (plutonium-239) ^a	0.000420		
Expanded Operations Alternative			
Actinides (plutonium-239) ^a	0.000760		
Fission Products ^b			
Krypton-85			100
Xenon-131m			23,480
Xenon-133			1,500
Tritium ^c		1,000	
Reduced Operations Alternative^d			
Actinides (plutonium-239) ^a	0.000380		
Greener Alternative^d			
Actinides (plutonium-239) ^a	0.000420		

Notes:

^a Actinides were not broken down by isotope; therefore, they were represented by plutonium-239. Actinides are emitted from Wings 2, 3, 4, 5, 6, 7, and 9, but no stacks were specified. The most conservative stack was chosen (ES–14 at Wing 2) to model emissions from all these wings.

^b Fission product emissions apply only to the Expanded Operations Alternative. Fission products are emitted from Wing 9. The most conservative stack (ES–46) was chosen for modeling.

^c Tritium emissions apply only to the Expanded Operations Alternative. Tritium is emitted from Wing 4. A new stack will be installed for it; no information on the stack parameters is available. The most conservative stack (ES–24) was chosen to model all tritium emissions from Wing 4.

^d The No Action and Greener Alternatives are the same. The Reduced Operations Alternative is 90 percent of the No Action Alternative.

TABLE B.1.1.4-2.—Radiological Air Emissions from TA-3-66 (Sigma)

STACK NUMBER						
	ES-1	ES-8	ES-9	ES-13 ^a	ES-24 ^a	ES-25/26 ^{b,c}
Percent Emissions ^d Uranium-238	2	2	2	45	45	4
STACK PARAMETERS						
Height (meters)	19.8	16.8	15.4	13.7	15.9	12.2
Diameter (meters)	1.2	2.8	1.8	0.4	1.1	0.3
Exit Velocity (meters per second)	14.4	1.1	4.9	51.8	14.6	1.8
EMISSION RATE PER STACK (CURIES PER YEAR) ^e						
No Action Alternative						
Uranium-234	0	0	0	0	0	0.0000220
Uranium-238	0.0000122	0.0000122	0.0000122	0.000275	0.000275	0.0000244
Expanded Operations Alternative						
Uranium-234	0	0	0	0	0	0.0000660
Uranium-238	0.0000360	0.0000360	0.0000360	0.000810	0.000810	0.0000720
Reduced Operations Alternative						
Uranium-234	0	0	0	0	0	0.0000220
Uranium-238	0.0000122	0.0000122	0.0000122	0.000275	0.000275	0.0000244
Greener Alternative						
Uranium-234	0	0	0	0	0	0.0000220
Uranium-238	0.0000122	0.0000122	0.0000122	0.000275	0.000275	0.0000244

Notes:

^a 90 percent of the depleted uranium (DU) (e.g., uranium-238) comes out of ES-13 and ES-24 (i.e., 45% each).^b No stack information is available for enriched uranium (EU) emissions; therefore, the most conservative emission stack (ES) is considered for emissions (stack ES-25).^c Stack ES-26 is added to stack ES-25 for similarity of parameters.^d All uranium-238 is assumed to be in equilibrium with thorium-234 and protactinium-234m. All DU is considered as uranium-238, and all EU is considered as uranium-234.^e The No Action, Greener, and Reduced Operations Alternatives are the same. The Expanded Operations Alternative is three times higher than the No Action Alternative.

TABLE B.1.1.4-3.—Radiological Air Emissions from TA-11 (High Explosives Testing)

RADIONUCLIDE	ALTERNATIVE (CURIES PER YEAR)			
	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Uranium-238 ^a	3.98×10^{-7}	9.96×10^{-7}	2.32×10^{-7}	2.32×10^{-7}
Uranium-235 ^b	7.56×10^{-9}	1.89×10^{-8}	4.41×10^{-9}	4.41×10^{-9}
Uranium-234 ^c	1.49×10^{-7}	3.71×10^{-7}	8.67×10^{-8}	8.67×10^{-8}

Notes:

^a Protactinium-234m and thorium-234 are in equilibrium with uranium-238.^b Thorium-231 is in equilibrium with uranium-235.^c No stack emissions. This is an area source. An area of 10,000 square meters (m²) was used. Areas of 100 and 1,000 m² were also used, with no difference in the results.**TABLE B.1.1.4-4.—Radiological Air Emissions from TA-16 (Tritium Facility)**

RADIONUCLIDE ^{a,b}	ALTERNATIVE (CURIES PER YEAR)			
	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Tritium (gaseous)	100	300	100	100
Tritium (water vapor)	300	500	300	300
Total	400	800	400	400

Notes:

^a Tritium is emitted in the gaseous form (HT) as well as in the water vapor form (HTO). CAP-88 uses the water vapor form of tritium for modeling for a conservative result because the vapor form produces the highest dose. It was assumed that all tritium is in the vapor form.^b Tritium is emitted from fan exhaust (FE)-4 in Building 205 (the only stack for tritium emissions at TA-16). The stack parameters are: Height = 18.3 meters, Diameter = 0.5 meter, and Exit Velocity = 19.3 meters per second.**TABLE B.1.1.4-5.—Radiological Air Emissions from TA-18 (Pajarito Site)**

RADIONUCLIDE ^{a,b}	ALTERNATIVE (CURIES PER YEAR)			
	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Argon-41	101	126	101	101

Notes:

^a No stack emissions. This is an area source. An area of 45,200 square meters (m²) was calculated based on the air volume used by LANL to calculate the emission rates.^b Argon-41 is the only significant radionuclide emitted from TA-18. Others are present in quantities too small to consider in this analysis.

TABLE B.1.1.4-6.—Radiological Air Emissions from TA-21 (Tritium Facility)

RADIONUCLIDE ^a	ALTERNATIVE (CURIES PER YEAR)			
	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
TA-21-155^b				
Tritium (gaseous)	100	100	100	100
Tritium (water vapor)	100	100	100	100
Total	200	200	200	200
TA-21-209^c				
Tritium (gaseous)	640	640	640	640
Tritium (water vapor)	860	860	860	860
Total	1,500	1,500	1,500	1,500

Notes:

^a Tritium is emitted in the gaseous form (HT) as well as in the water vapor form (HTO). CAP-88 uses the water vapor form of tritium for modeling for a conservative result, because the vapor form produces the highest dose. It was assumed that all tritium is in the vapor form.

^b The ES-5 stack parameters for TA-21-155 are: Height = 29.9 meters (m), Diameter = 0.8 m, Exit Velocity = 7.8 meters per second (m/s).

^c The ES-1 stack parameters for TA-21-209 are: Height = 23.2 m, Diameter = 1.2 m, Exit Velocity = 10.3 m/s.

TABLE B.1.1.4-7.—Radiological Air Emissions from TA-3-102 (Shops)

RADIONUCLIDE ^{a,b}	ALTERNATIVE (CURIES PER YEAR)			
	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Uranium-238	0.00005	0.00015	0.00005	0.00005

Notes:

^a Protactinium-234m and thorium-234 are in equilibrium with uranium-238.

^b The ES-22 stack parameters are: Height = 11.9 meters, Diameter = 0.9 meter, Exit Velocity = 0.8 meters per second.

TABLE B.1.1.4–8.—Radiological Air Emissions from TA–48 (Radiochemistry Laboratory)

FAN EXHAUST (FE) NUMBER (STACK NUMBER)				
	FE–15 (16)	FE–4 (11) ^a	FE–45/46	FE–51/54
FAN EXHAUST PARAMETERS				
Height (meters)	19.8	20.1	15.2	13.1
Diameter (meters)	1.5	1.8	1.8	0.9
Velocity (meters per second)	13.5	9.9	8.2	7.9
EMISSION RATE PER FAN EXHAUST (CURIES PER YEAR)				
No Action Alternative				
Mixed Fission Product ^b	0.000015	0.00008	0.0000126	1.10×10^{-6}
Plutonium-239	4.50×10^{-6}	4.70×10^{-7}	4.70×10^{-7}	6.20×10^{-8}
Expanded Operations Alternative				
Mixed Fission Product ^b	0.000033	0.000088	0.000018	2.20×10^{-6}
Plutonium-239	9.60×10^{-6}	5.20×10^{-7}	6.50×10^{-7}	1.20×10^{-7}
Reduced Operations Alternative				
Mixed Fission Product ^b	0.000015	0.00004	0.000013	5.30×10^{-7}
Plutonium-239	4.50×10^{-6}	2.40×10^{-7}	4.60×10^{-7}	3.10×10^{-8}
Greener Alternative				
Mixed Fission Product ^b	0.000033	0.00008	0.000018	1.10×10^{-6}
Plutonium-239	9.60×10^{-6}	4.70×10^{-7}	6.50×10^{-7}	6.20×10^{-8}

Notes:

^a Fan exhaust FE–4 exits through Stack 11.^b The mixed fission products are represented by strontium-90/yttrium-90 in equilibrium.

TABLE B.1.1.4-9.—Radiological Air Emissions from TA-48 (Radiochemistry Laboratory)^a

ALTERNATIVE	NO ACTION		EXPANDED OPERATIONS		REDUCED OPERATIONS		GREENER	
FAN EXHAUST NUMBER	FE-60	FE-63/64	FE-60	FE-63/64 ^b	FE-60	FE-63/64	FE-60	FE-63/64
FAN EXHAUST PARAMETERS								
Height (meters)	12.4	10.3	12.4	10.3	12.4	10.3	12.4	10.3
Diameter (meters)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Exit Velocity (meters per second)	9.4	12.5	9.4	12.5	9.4	12.5	9.4	12.5
EMISSION RATE PER FAN EXHAUST (CURIES PER YEAR)								
Emission:								
Mixed Activation Products ^c	1.60×10^{-7}	1.40×10^{-6}	3.20×10^{-7}	2.80×10^{-6}	8.00×10^{-8}	7.00×10^{-7}	1.60×10^{-7}	1.40×10^{-6}
Arsenic-72	0	0.000056	0	0.00011	0	0.000028	0	0.000056
Arsenic-73	0	0.000095	0	0.00019	0	0.0000475	0	0.000095
Arsenic-74	8.50×10^{-7}	0.000019	1.70×10^{-6}	0.000038	4.25×10^{-7}	9.50×10^{-6}	8.50×10^{-7}	0.000019
Beryllium-7	7.30×10^{-6}	6.10×10^{-8}	0.000015	1.20×10^{-7}	3.65×10^{-6}	3.05×10^{-8}	7.30×10^{-6}	6.10×10^{-8}
Bromine-77	0.00031	0.00012	0.00062	0.00024	0.000155	0.00006	0.00031	0.00012
Germanium-68	0	8.50×10^{-6}	0	0.000017	0	4.25×10^{-6}	0	8.50×10^{-6}
Rubidium-86	0	1.40×10^{-7}	0	2.80×10^{-7}	0	7.00×10^{-8}	0	1.40×10^{-7}
Selenium-75	0.000044	0.00012	0.000089	0.00024	0.000022	0.00006	0.000044	0.00012

Notes:

^a These isotopes were modeled using LANL's mainframe computer.^b Fan exhausts FE-63/64 exit through Stack 7.^c The mixed activation products are represented by strontium-90/yttrium-90 in equilibrium.**TABLE B.1.1.4-10.—Radiological Air Emissions from TA-55 (Plutonium Facility)**

RADIONUCLIDE	ALTERNATIVE (CURIES PER YEAR)			
	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
ES-15 (North Stack) ^a	1.52×10^{-6}	2.50×10^{-6}	1.38×10^{-6}	2.00×10^{-6}
ES-16 (South Stack) ^b				
Particulates (plutonium-239) ^c	0.0000162	0.000026	7.91×10^{-6}	0.0000157
Tritium	1,000	100	100	100

Notes:

^a The ES-15 stack parameters are: Height = 14 meters (m), Diameter = 1.1 m, and Exit Velocity = 6.8 meters per second (m/s).^b The ES-16 stack parameters are: Height = 14 m, Diameter = 1.1 m, and Exit Velocity = 10.8 m/s.^c No isotopic breakdown of particulates is available; therefore, all particulates are represented by plutonium-239.

TABLE B.1.1.4–11.—Radiological Air Emissions from TA–15 and TA–36 (Firing Sites)

ALTERNATIVE	RADIONUCLIDE (CURIES PER YEAR) ^{a,b}		
	URANIUM-238	URANIUM-235	URANIUM-234
NO ACTION			
TA–15	0.0226	0.000437	0.00842
TA–36	0.012	0.000233	0.00449
Total	0.0346	0.00067	0.0129
EXPANDED OPERATIONS			
TA–15	0.0693	0.00134	0.0258
TA–36	0.0346	0.00067	0.0129
Total	0.104	0.00201	0.0387
REDUCED OPERATIONS			
TA–15	0.0226	0.000437	0.00842
TA–36	0.012	0.000233	0.00449
Total	0.0346	0.00067	0.0129
GREENER			
TA–15	0.0226	0.000437	0.00842
TA–36	0.012	0.000233	0.00449
Total	0.0346	0.00067	0.0129

Notes:

^a No stack emissions. This is an area source. An area of 100 square meters was used. This value was used based on information obtained from LANL personnel regarding the area of pads used for firing experiments.

^b These values are for the resuspendable and/or respirable portion of the product used during the tests and as such are the values used as the source parameter in the CAP–88 PC Model.

TABLE B.1.1.4-12.—Radiological Air Emissions from TA-54 (Area G—Waste Management)

RADIONUCLIDE ^b	ALTERNATIVE (CURIES PER YEAR) ^a			
	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Tritium	21	21	21	21
Americium-241	6.60×10^{-7}	6.60×10^{-7}	6.60×10^{-7}	6.60×10^{-7}
Plutonium-238	4.80×10^{-6}	4.80×10^{-6}	4.80×10^{-6}	4.80×10^{-6}
Plutonium-239	6.80×10^{-7}	6.80×10^{-7}	6.80×10^{-7}	6.80×10^{-7}
Uranium-234	8.00×10^{-6}	8.00×10^{-6}	8.00×10^{-6}	8.00×10^{-6}
Uranium-235	4.10×10^{-7}	4.10×10^{-7}	4.10×10^{-7}	4.10×10^{-7}
Uranium-238	4.00×10^{-6}	4.00×10^{-6}	4.00×10^{-6}	4.00×10^{-6}

Notes:

^a No change in emissions is expected among the SWEIS alternatives. These emissions were back-calculated using the CAP-88 model and are conservatively based on the average, plus two standard deviations of nearby environmental concentration measurements.

^b No stack emissions. This is an area source. An area of 5,000 square meters was used. This value was used based on information obtained from LANL personnel regarding the area of waste disposal.

TABLE B.1.1.4-13.—Radiological Air Emissions from TA-53 (LANSCE—ES-2 Stack)^{a,b}

RADIONUCLIDE	ALTERNATIVE (CURIES PER YEAR) ^c			
	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Argon-41	55.2	69.0	27.6	69.0
Carbon-10	2.12	2.65	1.06	2.65
Carbon-11	2,240	2,790	1,120	2,790
Nitrogen-13	348	434	174	434
Oxygen-14	5.29	6.61	2.65	6.61
Oxygen-15	464	581	233	581

Notes:

^a TA-53 emissions were divided into five sources: ES-2 stack emissions, ES-3 stack emissions, LEDA emissions, IPF-2 emissions, and diffuse emissions.

^b ES-2 stack emissions: evacuation from the Manuel Lujan Neutron Scattering Center (MLNSC), Weapons Neutron Research (WNR), and Line D-South. Parameters are: Height = 13 meters (m), Diameter = 0.9 m, Exit Velocity = 7 meters per second.

^c Increased by factor of 200/70 to account for increased beam current.

TABLE B.1.1.4–14.—Radiological Air Emissions from TA–53 (LANSCE—ES–3 Stack)^{a,b}

RADIONUCLIDE	ALTERNATIVE (CURIES PER YEAR)			
	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Argon-41	345	862	172	862
Carbon-11	3,100	7,760	1,550	7,760

Notes:

^a TA–53 emissions were divided into five sources: ES–2 stack emissions, ES–3 stack emissions, LEDA emissions, IPF–2 emissions, and diffuse emissions.

^b ES–3 stack emissions: evacuation from experimental areas A, B, and C, and associated lines B and C tunnels. Parameters are: Height = 30.5 meters (m), Diameter = 0.9 m, Exit Velocity = 12.5 meters per second.

TABLE B.1.1.4–15.—Radiological Air Emissions from TA–53 (LANSCE—LEDA)^{a,b}

RADIONUCLIDE	ALTERNATIVE (CURIES PER YEAR)			
	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Argon-41		2.29	2.29	2.29
Nitrogen-13	0.163	0.163	0.163	0.163
Nitrogen-16	0.0285	0.0285	0.0285	0.0285
Oxygen-15	0.00177	0.00177	0.00177	0.00177
Oxygen-19	0.00216	0.00216	0.00216	0.00216
Sulfur-37	0.00181	0.00181	0.00181	0.00181
Chlorine-39	0.00047	0.00047	0.00047	0.00047
Chlorine-40	0.00219	0.00219	0.00219	0.00219
Krypton-83m	0.00221	0.00221	0.00221	0.00221
Others	0.00111	0.00111	0.00111	0.00111

Notes:

^a TA–53 emissions were divided into five sources: ES–2 stack emissions, ES–3 stack emissions, LEDA emissions, IPF–2 emissions, and diffuse emissions.

^b LEDA emissions: evacuation from the Low Energy Demonstration Accelerator. Emissions were assumed to exit through the ES–3 stack with parameters: Height = 30.5 meters (m), Diameter = 0.9 m, Exit Velocity = 12.5 meters per second.

TABLE B.1.1.4-16.—Radiological Air Emissions from TA-53 (LANSCE—IPF-2)^{a,b}

RADIONUCLIDE	ALTERNATIVE (CURIES PER YEAR)			
	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Carbon-11	70	87.5	35	87.5
Nitrogen-13	80	100	40	100
Oxygen-15	20	25	10	25

Notes:

^a TA-53 emissions were divided into five sources: ES-2 stack emissions, ES-3 stack emissions, LEDA emissions, IPF-2 emissions, and diffuse emissions.

^b IPF-2 emissions: evacuation from the Isotope Production Facility 2. Emissions were assumed to exit through the ES-3 stack with parameters: Height = 30.5 meters (m), Diameter = 0.9 m, Exit Velocity = 12.5 meters per second.

TABLE B.1.1.4-17.—Radiological Air Emissions from TA-53 (LANSCE—Diffuse)^{a,b}

RADIONUCLIDE	ALTERNATIVE (CURIES PER YEAR)			
	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Argon-41	2.56	3.2	1.28	3.2
Carbon-11	61.44	76.8	30.72	76.8

Notes:

^a TA-53 emissions were divided into five sources: ES-2 stack emissions, ES-3 stack emissions, LEDA emissions, IPF-2 emissions, and diffuse emissions.

^b Diffuse emissions: escape from the area around the high intensity beam line (Line A). No stack emissions.

- All uranium-238 emissions were assumed to be in equilibrium with its decay daughters, thorium-234 and protactinium-234m.
- Unidentified mixed fission products (MFPs) or MAPs are modeled as strontium-90/yttrium-90 in equilibrium. This was done for some unidentified MAPs from the Low Energy Demonstration Accelerator (LEDA) emissions at the LANSCE and for some MAPs and MFPs from TA-48.
- Tritium can exist in gaseous (elemental tritium) or water vapor (tritium oxide) forms. The oxide form is used in CAP-88 to ensure conservative results because it produces a higher dose. All tritium emissions were modeled as oxides from TA-16 and TA-21 (the tritium facilities).

Source Parameters

LANL emission sources include individual stacks and large area (diffuse) sources. For stack emissions, the actual stack heights, diameters, and exit velocities were used. These stack parameters are reflected in Tables B.1.1.4-1 through B.1.1.4-17.

The sizes of area sources were calculated based on site information. Because the sizes of area sources could not always be precisely determined, a sensitivity analysis was performed using various area sizes. This analysis was performed by changing the sizes of the areas modeled while fixing all other parameters. Areas of 1,075, 10,750, and 107,500 square feet (100, 1,000, and 10,000 square meters) were used in separate model runs

for the same case, and the results in all three runs were exactly the same. The conclusion was that the resultant dose was independent of the size of the area source if the radionuclide emission rates was the same due to the distance of the modeled MEI or member of the population from the area source. Despite this sensitivity analysis, the best estimate of an area's size was used in all cases for the actual modeling.

Agricultural Data

Radionuclides emitted to the air and subsequently ingested with food crops is one pathway of exposure used by CAP-88. The immediate region surrounding the LANL site does not have any major agricultural production activities; however, the agricultural data used in the modeling effort are reflected in Table B.1.1.4-18 (EPA 1992a).

These agricultural data were provided in the CAP-88 database for the State of New Mexico. Using these parameters may have resulted in an overestimate of the dose to individuals living in close proximity to the LANL site.

Meteorological Data

Meteorological data are used in conjunction with the CAP-88 model to estimate air dispersion of emitted nuclides. There were four meteorological towers distributed over the LANL sites used for this purpose. The meteorological data used for each tower were the average of 3 years of actual meteorological data. The tower nearest to the modeled facility was used for input data, as reflected below.

TABLE B.1.1.4-18.—*Fraction of Agricultural Products Produced in the Home, Assessment Area, and Imported*

	VEGETABLE	MILK	MEAT
Fraction Home Produced	0.7	0.399	0.442
Fraction Assessment Area Produced	0.3	0.601	0.558
Fraction Imported	0	0	0

- *TA-6 Tower*—Used for modeling emissions from TA-3, TA-16, TA-48, and TA-55
- *TA-49 Tower*—Used for modeling emissions from TA-15 and TA-36
- *TA-53 Tower*—Used for modeling emissions from TA-21 and TA-53
- *TA-54 Tower*—Used for modeling emissions from TA-18 and TA-54

The use of 3 years' data for modeling purposes is due to the fact that these towers have existed in these locations for that period of time. The use of average meteorological data over this period is expected to reflect future conditions more accurately than data from any individual year.

Other meteorological data needed as input to CAP-88 are:

- Annual precipitation = 19 inches (48 centimeters) per year (Bowen 1990)
- Annual ambient temperature = 48°F (8.8°C) (Bowen 1990)
- Height of lid = 5,000 feet (1,525 meters)
The lid height (vertical extent of mixing of air emissions) was obtained from the weather center in Albuquerque and was verified by the National Oceanographic and Atmospheric Administration.

Distances Between Emission Points and Receptors

The distances between the emission sources and the specific location modeled must be introduced as input parameters for CAP-88 to calculate the nuclide concentration and subsequent doses at that location. Map coordinates for each source at LANL and each receptor location were determined using large maps and Geographic Information System (GIS) graphics. The distances were then calculated using these coordinate points. The distances and direction between each modeled facility and the facility-specific MEI location are listed in Table B.1.1.4–19.

Population Data

Data regarding the population distribution within a 50-mile (80-kilometer) radius around LANL are needed by CAP-88 for the calculation of the collective population dose. LANL has been using a population data file that was prepared based on the 1990 Census (DOC 1991). A new population data file was prepared by the University of Nevada (UN) in 1995, using data from the New Mexico Bureau of Business and Economic Research (BBER 1995). The UN data file was used for all CAP-88 population runs, consistent with the socioeconomic data used for the SWEIS. There are no significant differences between the LANL data file and the UN data file.

The input parameters described above were input into the CAP-88 model to generate the estimated radionuclide concentrations and resulting radiation dose equivalents. Various receptors were modeled as bounding estimates. These receptors are discussed individually below.

B.1.1.5 Facility-Specific Maximally Exposed Individual Doses

CAP-88 runs were made using each modeled facility's air emissions to determine the CEDE at various locations. The results were examined, and a single point at the LANL boundary where the highest dose occurs was identified. The distance and direction to these points were determined. These points are the locations of the facility-specific MEIs. The distances and directions of all facility-specific MEIs are listed in Table B.1.1.5–1. The distances and directions for all MEIs, with respect to all modeled facilities, are presented in Table B.1.1.4–19, as noted above. The dose commitment from all facility emissions were then calculated for each FS MEI location and summed to provide the total dose at that location. The contribution from each modeled

TABLE B.1.1.4-19.—Distances (Meters) and Directions Between the Modeled Facilities and the Facility-Specific MEI

MODELED FACILITY	MEI		TA-3-29 CMR; TA-3-66 SIGMA	TA-48 RADIO-CHEMISTRY LAB; TA-55 PLUTONIUM FACILITY	TA-3-102 MAIN SHOPS	TA-16 TRITIUM FACILITY	TA-18 PAJARITO SITE	TA-21 TRITIUM FACILITY	TA-53 LANSCE	TA-54 AREA G ^a	TA-54 AREA G ^b	TA-15/36 FIRING SITES	TA-11 HIGH EXPLOSIVES TESTING
	NORTHING	EASTING											
TA-3-29 (CMR)	1772369	1619014	1,619,600	1,624,900	1,618,100	1,611,100	1,636,900	1,634,200	1,638,700	1,645,600	1,649,200	1,632,900	1,615,100
			3,575	5,955	3,265	15,960	19,785	15,455	19,765	29,940	34,975	15,110	15,420
TA-3-66 (Sigma)	1772352	1619258	N	E	NNW	SSW	ESE	E	E	ESE	ESE	ESE	SSW
			3,560	5,725	3,345	16,075	19,570	15,205	19,520	29,710	34,760	14,880	15,520
TA-3-102 (Shops)	1772127	1618300	N	E	NW	SW	ESE	E	E	ESE	ESE	ESE	SSW
			3,990	6,710	3,380	15,420	20,340	16,190	20,490	30,460	35,480	15,680	15,075
TA-16 (Tritium Facility)	1760866	1609447	NNE	E	N	SSW	ESE	E	E	ESE	ESE	ESE	SSW
			18,145	19,835	16,995	2,885	27,625	28,610	32,105	36,220	40,225	24,100	6,625
TA-18 (Pajarito Site)	1761900	1634900	NE	NE	NNE	SSE	ESE	ENE	ENE	ESE	ESE	ENE	ESE
			20,735	15,155	21,620	24,050	2,820	13,320	12,780	11,205	16,010	4,920	20,310
TA-21 (Tritium Facility)	1774175	1633991	NW	NW	NW	W	NE	N	NNE	ESE	ESE	NNW	W
			14,500	9,135	15,940	27,730	10,675	1,050	4,705	19,420	24,700	7,855	25,255
TA-48 (Radiochemistry Laboratory)	1770639	1623684	W	W	W	WSW	SSE	N	E	SE	SE	S	SW
			6,660	2,920	7,395	17,480	14,825	11,465	15,400	24,995	30,080	10,135	15,775
TA-53 (LANSCE)	1771546	1638133	NW	NNE	NW	SW	ESE	ENE	E	ESE	SE	ESE	SW
			19,025	13,350	20,420	30,010	7,740	5,365	2,625	14,940	20,155	7,345	27,025
TA-54 (Area G)	1757700	1644800	WNW	W	WNW	WSW	SSE	NW	NNE	SSE	SSE	SW	WSW
			31,080	25,270	32,080					1,195			
TA-55 (Plutonium Facility)	1769609	1624860	NW	NW	NW	W	NW	NNW	NNW	NE	SE	NW	W
			8,200	3,690	33,700	17,680	13,315	10,890	14,545	23,470	28,535	8,660	15,630
TA-15/36 (Firing Sites)	1759700	1629700	NW	N	NW	SW	ESE	ENE	ENE	ESE	ESE	ESE	SW
			19,090	14,415	19,600	18,630	8,330	16,140	16,975	15,940	20,125	7,415	14,775
			NNW	NNW	NW	W	ENE	ENE	NE	ESE	ESE	NE	W

TABLE B.1.1.4-19.—Distances (Meters) and Directions Between the Modeled Facilities and the Facility-Specific MEI-Continued

MODELED FACILITY	MEI		TA-3-29 CMR; TA-3-66 SIGMA	TA-48 RADIO- CHEMISTRY LAB; TA-55 PLUTONIUM FACILITY	TA-3-102 MAIN SHOPS	TA-16 TRITIUM FACILITY	TA-18 PAJARITO SITE	TA-21 TRITIUM FACILITY	TA-53 LANSCE	TA-54 AREA G ¹	TA-54 AREA G ²	TA-15/36 FIRING SITES	TA-11 HIGH EXPLOSIVES TESTING
TA-11 (High Explosives Testing)	1761700	1615300	14,825	15,055	14,070	5,280	21,715	23,220	26,470	30,455	34,605	18,205	4,300
			NNW	NE	NNW	SW	E	NE	ENE	ESE	ESE	ENE	S

Note: This table identifies the distance and direction from each modeled facility to each facility's MEI. These values were used as input parameters for CAP-88 model runs and to calculate the dose contribution from each modeled facility to each MEI. As an example, the LANSCE MEI is located about 4,705 feet east of TA-21. Northings and Eastings in the first two rows pertain to the MEIs; Northings and Eastings in the columns pertain to the modeled facilities.

^a Hypothetical site at boundary of LANL and San Ildefonso Pueblo.

^b Actual MEI in the town of White Rock.

TABLE B.1.1.5–1.—Distance and Directions to Facility-Specific Maximally Exposed Individuals

FACILITY	MEI DISTANCE FEET (METERS)	DIRECTION
TA–3–29 (CMR)	3,575 (1,090)	North
TA–3–66 (Sigma Building)	3,560 (1,085)	North
TA–3–102 (Machine Shops)	3,380 (1,030)	North
TA–11 (High Explosives Testing)	4,300 (1,310)	South
TA–15/36 (Firing Sites)	7,415 (2,260)	Northeast
TA–16 (WETF)	2,885 (880)	South-Southeast
TA–18 (Pajarito Site: LACEF)	2,820 (860)	Northeast
TA–21 (TSTA and TSFF)	1,050 (320)	North
TA–48 (Radiochemistry Laboratory)	2,920 (890)	North-Northeast
TA–53 (LANSCE)	2,625 (800)	North-Northeast
TA–54 (Area G)	1,195 (365)	Northeast—LANL Boundary
	5,330 (1,625)	Southeast—White Rock
TA–55 (Plutonium Facility)	3,690 (1,125)	North

Note: This table lists the facility-specific MEI location from each modeled facility. These data are also contained in Table B.1.1.4–19.

facility to each MEI was calculated for each of the four SWEIS alternatives.

The MEI locations do not necessarily represent actual residences or individuals. They are merely points at the LANL boundary where the highest potential dose occurs. Some points at the LANL boundary do have residences close to them. This is especially true for those TAs located in the northern part of the LANL site, such as TA–3 and TA–53.

Two FS MEI locations were considered for Area G because it borders San Ildefonso Pueblo land. The first location is at the LANL boundary, 1,197 feet (365 meters) northeast of Area G next to San Ildefonso land. No one currently lives in that location. The second location is in the town of White Rock, approximately 5,331 feet (1,625 meters) southeast of Area G.

Some modeled facilities share the same MEI location. TA–3–29 (CMR) and TA–3–66 (Sigma) share the same MEI location, as do

TA–48 (Radiochemistry Facility) and TA–55 (Plutonium Facility).

B.1.1.6 LANL Site-Wide Maximally Exposed Individual Dose

The LANL site-wide MEI dose was determined by examining the total dose to each FS MEI. The FS MEI with the highest total dose is considered to be the LANL site-wide MEI for that alternative. For every FS MEI location, the total dose is the dose contributed by that specific facility, plus any doses contributed by other modeled facilities.

B.1.1.7 Population Dose

The dose to the population living within a 50-mile (80-kilometer) radius from LANL was calculated by CAP–88 using the UN population data prepared from BBER data (BBER 1995). For each modeled facility, a population run was made for each of the four alternatives. The

results from each modeled facility for each alternative were added to obtain the total population dose for that alternative.

B.1.1.8 Isodose Maps

Isodose maps (maps showing lines of equal dose) were generated for the region within a 50-mile (80-kilometer) radius from LANL. The isodose maps show contour lines representing the annual individual dose at the points where the lines pass through. Four CAP-88 runs were made for each emission source for each alternative in order to generate data points sufficient to create the isodose maps. The following distances (in meters) were introduced as an input to CAP-88 runs to generate these maps:

- *Run No. 1*—300, 400, 500, 600, 700, 800, 900, 1,000, 1,100, 1,200, 1,300, 1,400, 1,500, 1,600, 1,800, 2,000, 2,200, 2,400, 2,600, and 2,800
- *Run No. 2*—3,000, 3,200, 3,400, 3,600, 3,800, 4,000, 4,200, 4,400, 4,600, 4,800, 5,000, 5,500, 6,000, 6,500, 7,000, 7,500, 8,000, 8,500, 9,000, and 9,500
- *Run No. 3*—10,000, 11,000, 12,000, 13,000, 14,000, 15,000, 16,000, 17,000, 18,000, 19,000, 20,000, 22,000, 24,000, 26,000, 28,000, 30,000, 32,000, 34,000, 36,000, and 38,000
- *Run No. 4*—40,000, 42,000, 44,000, 46,000, 48,000, 50,000, 52,000, 54,000, 56,000, 58,000, 60,000, 62,000, 64,000, 66,000, 68,000, 70,000, 72,500, 75,000, 77,500, and 80,000

Dose calculations were made at each distance in 16 directions around the emission source for each alternative. The results were then used to generate the isodose maps using GIS overlays. The results of the runs for all emission sources were summed to obtain the isodose maps for all of LANL operations. Two sets of isodose maps were generated. The first set of four maps (one map per alternative) covers the region around

LANL with an average individual dose higher than 1 millirem per year. The second set of four maps (one map per alternative) covers the rest of the 50-mile (80-kilometer) region where average individual doses were less than 1 millirem per year.

B.1.2 Results of Consequence Analyses

B.1.2.1 Doses to Facility-Specific Maximally Exposed Individuals

For each FS MEI, the total dose at the MEI location was calculated by adding the contributions from each modeled facility. The highest dose for an alternative is the LANL MEI for that alternative.

The contribution of each modeled facility to the FS MEIs for the four SWEIS alternatives are included in Tables B.1.2.1-1 through B.1.2.1-4. The totals shown on these tables are summarized in Table B.1.2.1-5.

B.1.2.2 Dose to the LANL Site-Wide Maximally Exposed Individual

As noted above, the LANL site-wide MEI is determined by identifying the FS MEI with the highest total dose. The location of and modeled dose to the LANL site-wide MEI for each alternative is summarized in Table B.1.2.2-1.

The NESHAP requires that the dose resulting from air emissions to the LANL MEI not exceed 10 millirem per year. As shown in Table B.1.2.2-1, this regulatory limit would not be exceeded under any of the SWEIS alternatives. In fact, the highest MEI dose was 5.44 millirem per year for the Expanded Operations Alternative, which is 54.4 percent of the

TABLE B.1.2.1-1.—Doses to Facility-Specific MEIs from LANL Operations for the No Action Alternative (millirems per year)

MEI SOURCE	TA-3-29/ TA-3-66 CMR AND SIGMA	TA-3-102 SHOPS	TA-11 HIGH EXPLOSIVES	TA-16 TRITIUM FACILITY	TA-18 PAJARITO SITE	TA-21 TRITIUM FACILITY	TA-48/55 RADIO- CHEMISTRY LABORATORY AND PLUTONIUM FACILITY	TA-53 LANSCÉ ^a	TA-54 AREA G (LANL BOUNDARY)	TA-54 AREA G (WHITE ROCK)	TA-15/36 FIRING SITES
TA-3-29 (CMR)	6.43E-02	4.67E-02	4.16E-03	3.93E-03	1.12E-02	1.48E-02	5.51E-02	1.12E-02	1.12E-03	5.12E-03	1.60E-02
TA-3-66 (Sigma)	3.41E-02	2.29E-02	2.30E-03	2.14E-03	6.62E-03	8.42E-03	2.96E-02	6.64E-03	3.74E-03	3.08E-03	9.28E-03
TA-3-102 (Shops)	2.93E-03	1.98E-03	1.72E-04	1.59E-04	4.79E-04	6.35E-04	3.04E-03	4.83E-04	2.62E-04	2.11E-04	6.98E-04
TA-11 (High Explosives Testing)	3.14E-06	4.56E-06	3.41E-05	1.26E-05	3.02E-06	2.25E-06	4.15E-06	1.90E-06	1.87E-06	1.38E-06	3.63E-06
TA-15/36 (Firing Sites)	1.04E-01	7.71E-02	1.21E-01	8.40E-02	1.05E+00	3.27E-01	1.62E-01	3.17E-01	4.24E-01	2.40E-01	1.16E+00
TA-16 (Tritium Facility)	1.68E-02	1.78E-02	8.18E-02	1.44E-01	1.32E-02	1.19E-02	1.54E-02	8.08E-03	7.01E-03	5.88E-03	1.41E-02
TA-18 (Pajarito Site)	3.50E-04	3.39E-04	5.41E-04	3.04E-04	8.63E-02	2.76E-03	6.90E-04	5.49E-03	1.42E-02	7.98E-03	7.30E-03
TA-21 (Tritium Facility)	4.72E-02	4.47E-02	4.04E-02	3.62E-02	1.07E-01	6.50E-01	1.56E-01	3.66E-01	5.33E-02	4.43E-02	2.53E-01
TA-48 (Gram calculation)	1.88E-04	1.58E-04	5.51E-05	4.25E-05	2.20E-04	2.06E-04	1.01E-03	1.73E-04	1.19E-04	8.99E-05	3.44E-04
TA-48 (LANL calculation)	1.53E-01	1.17E-01	5.05E-02	3.71E-02	2.20E-01	2.12E-01	1.22E+00	1.66E-01	1.02E-01	7.67E-02	3.60E-01
TA-53 Diffuse	7.27E-05	6.47E-05	5.06E-05	3.28E-05	2.84E-03	2.52E-03	2.43E-04	4.48E-02	4.88E-04	2.59E-04	2.29E-03
ES-2	2.53E-03	2.21E-03	1.75E-03	1.10E-03	1.07E-01	8.55E-02	8.71E-03	1.34E+00	1.87E-02	9.78E-03	8.17E-02
ES-3	4.61E-03	4.25E-03	3.54E-03	2.38E-03	1.20E-01	8.63E-02	1.40E-02	7.50E-01	2.75E-02	1.56E-02	9.46E-02
IPF-2	8.02E-05	7.12E-05	5.65E-05	3.47E-05	3.55E-03	2.52E-03	2.80E-04	3.00E-02	6.63E-04	3.52E-04	2.69E-03
LEDA	1.27E-04	1.28E-04	9.73E-05	7.32E-05	6.04E-04	4.41E-04	2.06E-04	2.12E-03	2.63E-04	1.95E-04	5.29E-04
TA-54 (Area G)	4.36E-04	4.00E-04	5.40E-04	2.11E-04	3.11E-03	6.04E-04	5.37E-04	6.46E-04	8.90E-02	2.21E-02	6.52E-04
TA-55 (Plutonium Facility)	1.45E-01	1.32E-01	2.69E-02	2.51E-02	9.05E-02	9.54E-02	3.37E-01	6.17E-02	5.18E-02	4.27E-02	2.59E-01
Total	0.58	0.47	0.33	0.34	1.82	1.50	2.00	3.11	0.08	0.47	2.26

^a This is also the LANL site-wide MEI because it has the highest dose among the facility-specific MEIs.

TABLE B.1.2.1-2.—Doses to Facility-Specific MEIs from LANL Operations for the Expanded Operations Alternative (millirems per year)

MEI SOURCE	TA-3-29/ TA-3-66 CMR AND SIGMA	TA-3-102 SHOPS	TA-11 HIGH EXPLOSIVES	TA-16 TRITIUM FACILITY	TA-18 PAJARITO SITE	TA-21 TRITIUM FACILITY	TA-48/55 RADIO- CHEMISTRY LABORATORY AND PLUTONIUM FACILITY	TA-53 LANSCÉ ^a	TA-54 AREA G (LANL BOUNDARY)	TA-54 AREA G (WHITE ROCK)	TA-15/36 FIRING SITES
TA-3-29 (CMR)	4.95E-01	3.86E-01	4.13E-02	3.98E-02	9.00E-02	1.11E-01	4.22E-01	9.00E-02	5.70E-02	4.38E-02	1.19E-01
TA-3-66 (Sigma)	1.02E-01	6.87E-02	6.90E-03	6.43E-03	1.99E-02	2.53E-02	8.89E-02	1.99E-02	1.12E-02	9.23E-03	2.78E-02
TA-3-102 (Shops)	8.36E-03	9.33E-03	5.97E-04	5.14E-04	1.35E-03	1.76E-03	6.93E-03	1.35E-03	7.60E-04	6.14E-04	1.92E-03
TA-11 (High Explosives Testing)	1.03E-05	1.14E-05	8.52E-05	3.16E-05	7.54E-06	5.62E-06	1.04E-05	4.76E-06	4.68E-06	3.46E-06	9.08E-06
TA-15/36 (Firing Sites)	3.13E-01	2.31E-01	3.64E-01	2.52E-01	3.15E+00	9.81E-01	4.86E-01	9.52E-01	1.27E+00	7.20E-01	3.48E+00
TA-16 (Tritium Facility)	3.36E-02	3.56E-02	1.64E-01	2.87E-01	2.65E-02	2.38E-02	3.07E-02	1.62E-02	1.40E-02	1.18E-02	2.81E-02
TA-18 (Pajarito Site)	4.37E-04	4.24E-04	6.76E-04	3.80E-04	1.08E-01	3.45E-03	8.63E-04	6.86E-03	1.77E-02	9.98E-03	9.13E-03
TA-21 (Tritium Facility)	4.72E-02	4.47E-02	4.04E-02	3.62E-02	1.07E-01	6.50E-01	1.56E-01	3.66E-01	5.33E-02	4.43E-02	2.53E-01
TA-48 (GRAM calculation)	3.23E-04	2.66E-04	9.75E-05	7.39E-05	4.09E-04	3.88E-04	1.83E-03	3.19E-04	2.18E-04	1.64E-04	6.33E-04
TA-48 (LANL calculation)	3.07E-01	2.33E-01	1.01E-01	7.42E-02	4.40E-01	4.24E-01	2.43E+00	3.32E-01	2.03E-01	1.53E-01	7.21E-01
TA-53 Diffuse	9.08E-05	8.09E-05	6.33E-05	4.10E-05	3.55E-03	3.15E-03	3.04E-04	5.60E-02	6.10E-04	3.24E-04	2.86E-03
ES-2	3.16E-03	2.76E-03	2.19E-03	1.37E-03	1.33E-01	1.07E-01	1.09E-02	1.68E+00	2.33E-02	1.22E-02	1.02E-01
ES-3	1.15E-02	1.06E-02	8.85E-03	5.95E-03	2.99E-01	2.16E-01	3.49E-02	1.88E+00	6.89E-02	3.89E-02	2.37E-01
IPF-2	1.00E-04	8.90E-05	7.07E-05	4.34E-05	4.44E-03	3.15E-03	3.50E-04	3.75E-02	8.28E-04	4.40E-04	3.36E-03
LEDA	1.27E-04	1.28E-04	9.73E-05	7.32E-05	6.04E-04	4.41E-04	2.06E-04	2.12E-03	2.63E-04	1.95E-04	5.29E-04
TA-54 (Area G)	4.36E-04	4.00E-04	5.40E-04	2.11E-04	3.11E-03	6.04E-04	5.37E-04	6.46E-04	8.90E-02	2.21E-02	6.52E-04
TA-55 (Plutonium Facility)	1.48E-02	1.37E-02	2.88E-03	2.68E-03	1.01E-02	1.05E-02	3.67E-02	6.90E-03	5.74E-03	4.67E-03	2.80E-02
Total	1.32	1.02	0.73	0.70	4.39	2.55	3.67	5.44	1.81	1.07	4.99

^a This is also the LANL site-wide MEI because it has the highest dose among the facility-specific MEIs.

TABLE B.1.2.1-3.—Doses to Facility-Specific MEIs from LANL Operations for the Reduced Operations Alternative (millirems per year)

MEI SOURCE	TA-3-29/ TA-3-66 CMR AND SIGMA	TA-3-102 SHOPS	TA-11 HIGH EXPLOSIVES	TA-16 TRITIUM FACILITY	TA-18 PAJARITO SITE	TA-21 TRITIUM FACILITY	TA-48/55 RADIO- CHEMISTRY LABORATORY AND PLUTONIUM FACILITY	TA-53 LANSCÉ	TA-54 AREA G (LANL BOUNDARY)	TA-54 AREA G (WHITE ROCK)	TA-15/36 FIRING SITES ^a
TA-3-29 (CMR)	5.79E-02	4.20E-02	3.75E-03	3.54E-03	1.00E-02	1.33E-02	4.96E-02	1.01E-02	5.68E-03	4.61E-03	1.44E-02
TA-3-66 (Sigma)	3.41E-02	2.29E-02	2.30E-03	2.14E-03	6.62E-03	8.42E-03	2.96E-02	6.64E-03	3.74E-03	3.08E-03	9.28E-03
TA-3-102 (Shops)	2.79E-03	3.11E-03	1.99E-04	1.71E-04	4.48E-04	5.86E-04	2.31E-03	4.50E-04	2.53E-04	2.05E-04	6.40E-04
TA-11 (High Explosives Testing)	2.48E-06	2.74E-06	2.04E-05	7.58E-06	1.81E-06	1.35E-06	2.49E-06	1.14E-06	1.12E-06	8.30E-07	2.18E-06
TA-15/36 (Firing Sites)	1.04E-01	7.71E-02	1.21E-01	8.40E-02	1.05E+00	3.27E-01	1.62E-01	3.17E-01	4.24E-01	2.40E-01	116E+00
TA-16 (Tritium Facility)	1.97E-02	2.12E-02	1.08E-01	6.91E-02	1.60E-02	1.37E-02	1.95E-02	1.27E-02	1.18E-02	8.21E-03	1.79E-02
TA-18 (Pajarito Site)	3.50E-04	3.39E-04	5.41E-04	3.04E-04	8.63E-02	2.76E-03	6.90E-04	5.49E-03	1.42E-02	7.98E-03	7.30E-03
TA-21 (Tritium Facility)	4.72E-02	4.47E-02	4.04E-02	3.62E-02	1.07E-01	6.50E-01	1.56E-01	3.66E-01	5.33E-02	4.43E-02	2.53E-01
TA-48 (GRAM calculation)	1.56E-04	1.28E-04	4.72E-05	3.55E-05	1.98-04	1.86E-04	8.97E-04	1.54E-04	1.06E-04	7.98E-05	3.06E-04
TA-48 (LANL calculation)	7.66E-02	5.83E-02	2.53E-02	1.85E-02	1.10E-01	1.06E-01	6.08E-01	8.31E-02	5.08E-02	3.84E-02	1.80E-01
TA-53 Diffuse	3.63E-05	3.24E-05	2.53E-05	1.64E-05	1.42E-03	1.26E-03	1.22E-04	2.24E-02	2.44E-04	1.30E-04	1.14E-03
ES-2	1.23E-03	1.08E-03	8.52E-04	5.32E-04	5.18E-02	4.15E-02	4.23E-03	6.52E-01	9.07E-03	4.75E-03	3.98E-02
ES-3	2.31E-03	2.12E-03	1.77E-03	1.19E-03	5.99E-02	4.32E-02	6.98E-03	3.75E-01	1.38E-02	7.78E-03	4.73E-02
IPF-2	4.01E-05	3.56E-05	2.83E-05	1.74E-05	1.78E-03	1.26E-03	1.40E-04	1.50E-02	3.31E-04	1.76E-04	1.34E-03
LEDA	1.27E-04	1.28E-04	9.73E-05	7.32E-05	6.04E-04	4.41E-04	2.06E-04	2.12E-03	2.63E-04	1.95E-04	5.29E-04
TA-54 (Area G)	4.36E-04	4.00E-04	5.40E-04	2.11E-04	3.11E-03	6.04E-04	5.37E-04	6.46E-04	8.90E-02	2.2E-02	6.52E-04
TA-55 (Plutonium Facility)	1.46E-02	1.37E-02	2.73E-03	2.56E-03	9.41E-03	9.80E-03	3.47E-02	6.39E-03	5.36E-03	4.39E-03	2.60E-02
Total	0.36	0.29	0.31	0.22	1.51	1.22	1.08	1.88	0.68	0.39	1.76

Note: $6.43E-02 = 6.43 \times 10^{-2}$ ^aThis is also the LANL site-wide MEI because it has the highest dose among the facility-specific MEIs.

TABLE B.1.2.1-4.—Doses to Facility-Specific MEIs from LANL Operations for the Greener Alternative (millirems per year)

MEI SOURCE	TA-3-29/ TA-3-66 CMR AND SIGMA	TA-3-102 SHOPS	TA-11 HIGH EXPLOSIVES	TA-16 TRITIUM FACILITY	TA-18 PAJARITO SITE	TA-21 TRITIUM FACILITY	TA-48/55 RADIO- CHEMISTRY LABORATORY AND PLUTONIUM FACILITY	TA-53 LANSCÉ ^a	TA-54 AREA G (LANL BOUNDARY)	TA-54 AREA G (WHITE ROCK)	TA-15/36 FIRING SITES
TA-3-29 (CMR)	6.43E-02	4.67E-02	4.16E-03	3.93E-03	1.12E-02	1.48E-02	5.51E-02	1.12E-02	6.31E-03	5.12E-03	1.60E-02
TA-3-66 (Sigma)	3.41E-02	2.29E-02	2.30E-03	2.14E-03	6.62E-03	8.42E-03	2.96E-02	6.64E-03	3.74E-03	3.08E-03	9.28E-03
TA-3-102 (Shops)	2.79E-03	3.11E-03	1.99E-04	1.71E-04	4.48E-04	5.86E-04	2.31E-03	4.50E-04	2.53E-04	2.05E-04	6.40E-04
TA-11 (High Explosives Testing)	2.48E-06	2.74E-06	2.04E-05	7.58E-06	1.81E-06	1.35E-06	2.49E-06	1.14E-06	1.12E-06	8.30E-07	2.18E-06
TA-15/36 (Firing Sites)	1.04E-01	7.71E-02	1.21E-01	8.40E-02	1.05E+00	3.27E-01	1.62E-01	3.17E-01	4.24E-01	2.40E-01	1.16E+00
TA-16 (Tritium Facility)	1.68E-02	1.78E-02	8.18E-02	1.44E-01	1.32E-02	1.19E-02	1.54E-02	8.08E-03	7.01E-03	5.88E-03	1.41E-02
TA-18 (Pajarito Site)	3.50E-04	3.39E-04	5.41E-04	3.04E-04	8.63E-02	2.76E-03	6.90E-04	5.49E-03	1.42E-02	7.98E-03	7.30E-03
TA-21 (Tritium Facility)	4.72E-02	4.47E-02	4.04E-02	3.62E-02	1.07E-01	6.50E-01	1.56E-01	3.66E-01	5.33E-02	4.43E-02	2.53E-01
TA-48 (GRAM calculation)	3.13E-04	2.56E-04	9.63E-05	7.22E-05	4.05E-04	3.78E-04	1.81E-03	3.12E-04	2.12E-04	1.62E-04	6.22E-04
TA-48 (LANL calculation)	1.53E-01	1.17E-01	5.05E-02	3.71E-02	2.20E-01	2.12E-01	1.22E+00	1.66E-01	1.02E-01	7.67E-02	3.60E-01
TA-53 Diffuse	9.08E-05	8.09E-05	6.33E-05	4.10E-05	3.55E-03	3.15E-03	3.04E-04	5.60E-02	6.10E-04	3.24E-04	2.86E-03
ES-2	3.16E-03	2.76E-03	2.19E-03	1.37E-03	1.33E-01	1.07E-01	1.09E-02	1.68E+00	2.33E-02	1.22E-02	1.02E-01
ES-3	1.15E-02	1.06E-02	8.85E-03	5.95E-03	2.99E-01	2.16E-01	3.49E-02	1.88E+00	6.89E-02	3.89E-02	2.37E-01
IPF-2	1.00E-04	8.90E-05	7.07E-05	4.34E-05	4.44E-03	3.15E-03	3.50E-04	3.75E-02	8.28E-04	4.40E-04	3.36E-03
LEDA	1.27E-04	1.28E-04	9.73E-05	7.32E-05	6.04E-04	4.41E-04	2.06E-04	2.12E-03	2.63E-04	1.95E-04	5.29E-04
TA-54 (Area G)	4.36E-04	4.00E-04	5.40E-04	2.11E-04	3.11E-03	6.04E-04	5.37E-04	6.46E-04	8.90E-02	2.21E-02	6.52E-04
TA-55 (Plutonium Facility)	1.48E-02	1.37E-02	2.80E-03	2.61E-03	9.74E-03	1.02E-02	3.57E-02	6.64E-03	5.53E-03	4.51E-03	2.70E-02
Total	0.35	0.28	0.31	0.31	1.93	1.54	1.64	4.52	0.79	0.45	2.17

^aThis is also the LANL site-wide MEI because it has the highest dose among the facility-specific MEIs.

TABLE B.1.2.1-5.—Total Doses to the Facility-Specific Maximally Exposed Individuals from LANL Operations (millirems per year)

MEI ALTERNATIVE	TA-3-29 CMR; TA-3-66 SIGMA	TA-3-102 MACHINE SHOPS	TA-11 HIGH EXPLOSIVES TESTING	TA-16 TRITIUM FACILITY	TA-18 PAJARITO SITE	TA-21 TRITIUM FACILITY	TA-48 RADIO- CHEMISTRY LABORATORY TA-55 PLUTONIUM FACILITY	TA-53 LANSCE	TA-54 AREA-G (LANL BOUNDARY)	TA-54 AREA-G (WHITE ROCK)	TA-15/36 FIRING SITES
No Action	0.43	0.34	0.31	0.31	1.73	1.41	1.66	3.11	0.75	0.43	2.26
Expanded Operations	1.32	1.02	0.73	0.70	4.39	2.55	3.67	5.44	1.81	1.07	4.99
Reduced Operations	0.36	0.29	0.31	0.22	1.51	1.22	1.08	1.88	0.68	0.39	1.76
Greener	0.35	0.28	0.31	0.31	1.93	1.54	1.64	4.52	0.79	0.45	2.17

TABLE B.1.2.2-1.—Doses to the LANL Site-Wide Maximally Exposed Individual for Each of the SWEIS Alternatives

ALTERNATIVE	DOSE (mrem/yr)	PERCENT OF NESHAP LIMIT	LOCATION
No Action	3.11	31.1	2,625 feet (800 meters) north-northeast of LANSCE
Expanded Operations	5.44	54.4	2,625 feet (800 meters) north northeast of LANSCE
Reduced Operations	1.88	18.8	2,625 feet (800 meters) north northeast of LANSCE
Greener	4.52	45.2	2,625 feet (800 meters) north-northeast of LANSCE

NESHAP = National Emissions Standards for Hazardous Air Pollutants (40 CFR 61, Subpart H).

regulatory limit. The LANL MEI is the LANSCE FS MEI under all alternatives.

B.1.2.3 *Collective Population Dose*

The collective dose to the population living within a 50-mile (80-kilometer) radius from LANL has been calculated for emissions from all modeled facilities. The population doses from each source for all four alternatives are presented in Table B.1.2.3–1, while the total collective population doses for the four SWEIS alternatives are presented in Table B.1.2.3–2.

An examination of Table B.1.2.3–1 reveals that most of the population dose comes from emissions from the Firing Sites. The Firing Sites emit long-lived uranium isotopes that can travel long distances without any significant decay. The emissions from LANSCE are mainly short-lived activation products that decay away in a matter of minutes or even seconds. Thus, the LANSCE emissions are important contributors to doses to individuals near LANL, but these emissions are less important to the doses for individuals farther away from LANL.

TABLE B.1.2.3–1.—Collective Population Dose to Residents Within a 50-mile Radius from LANL (person-rem/year)

	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
CMR	0.195	1.76	0.1755	0.195
Sigma	0.122	0.366	0.122	0.122
TA–11 (HE)	0.0000817	0.000204	0.000049	0.000049
TA–16 (Tritium)	0.276	0.552	0.276	0.276
TA–18	0.0720	0.900	0.0720	0.0720
TA–21 (Tritium)	0.977	0.977	0.977	0.977
Main Shops	0.0101	0.0303	0.0101	0.0101
TA–48 (GRAM)	0.00267	0.00508	0.00244	0.0051
TA–48 (LANL)	3.03	6.06	1.515	3.03
TA–55	0.81	0.0934	0.0845	0.0884
TA–15/–36 (Firing Sites)	7.07	21.21	7.07	7.07
TA–53				
ES–3	0.538	1.345	0.269	1.345
ES–2	0.429	0.536	0.209	0.536
LEDA	0.00327	0.00327	0.00327	0.00327
IPF–2	0.0145	0.0181	0.0073	0.0181
Diffuse	0.0118	0.0148	0.0059	0.0148
TA–54 (Waste Management)	0.0288	0.0288	0.0288	0.0288
Total ^a	13.59	33.09	10.83	13.79

^a The values reported for population doses for this alternative, as well as the other alternatives, is higher than has been reported in the recent Annual Environmental Reports. It is important to recognize that the alternatives analyzed represent increased operations when compared to recent history. The material throughput at the different facilities under the various alternatives is presented in section 3.6.

TABLE B.1.2.3–2.—Total Collective Population Doses for Each of the SWEIS Alternatives

ALTERNATIVE	DOSE (PERSON-REM/YR)
No Action	13.59
Expanded Operations	33.09
Reduced Operations	10.83
Greener	13.79

B.1.2.4 *Isodose Maps*

Individual doses have been calculated for people living within a 50-mile (80-kilometer) radius from LANL. The highest individual dose for an alternative is the dose given to the LANL site-wide MEI for that alternative. For the 50-mile (80-kilometer) region, an individual's doses are shown on the isodose maps in Figures B.1.2.4–1 through B.1.2.4–8. Figures B.1.2.4–1 through B.1.2.4–4 show doses that are more than 1 millirem per year for each of the four alternatives. Only lines that represent a dose larger than 1 millirem per year and extend (at least in part) outside the LANL boundary are shown on the isodose maps. Figures B.1.2.4–5 through B.1.2.4–8 show doses that are less than 1 millirem per year for each alternative. To estimate their doses, individuals need only find their locations on the isodose map and identify the bounding doses nearest that location. A dose of 1 millirem per year is not considered significant

B.1.2.5 *Uncertainties*

There are many factors that introduce uncertainties into the process of projecting future doses to the public from radioactive air emissions from LANL. Some of these factors are listed below.

- The radionuclide emission rates estimated by each modeled facility are based on current knowledge regarding future operations at the facility. However, the level of funding, exact activities, and exact conditions associated with future operations cannot be predicted with certainty. Therefore, the emission rate estimates cannot be viewed as accurate or precise values.
- The LANL site-wide MEI dose is sensitive to the assumptions and operations associated with LANSCE. Procedures are in place to monitor the modeled MEI dose and ensure that the 10 millirem per year limit is not exceeded. Population doses, on the other hand, are more sensitive to the assumptions and operations associated with the Firing Sites. For example, a 25 percent change in uranium use (which is assumed to mean a 25 percent change in uranium emissions) would change the population dose by about 20 percent.
- The parameters introduced into the CAP-88 model cannot be exact, especially the meteorological data. The average meteorology for a 3-year period was used in the modeling, which is a reasonable and good prediction for future years. However, any single, future year could be anomalous, resulting in a collective dose estimate different from that presented in this report. Again, active monitoring and control of atmospheric releases is conducted to ensure that the public dose limits are not exceeded.
- The modeled dose is also very sensitive to the assumed period of exposure. For the purposes of this analysis, the very conservative assumption is made that the MEI is a person who stays in the same location 24 hours a day, 365 days a year. Furthermore, it is assumed that this person is not shielded from the emissions by clothing or shelter (e.g., a building, auto, home, etc.).
- The area source term for TA-54 was calculated from AIRNET monitoring data.

There are uncertainties in those data for tritium in its water vapor form due to a recent discovery that the silica gel samplers are not collecting water with a high efficiency. It is estimated that the

underestimation, which is being quantified, will represent only a very small addition to the collective population dose and LANL MEI doses.

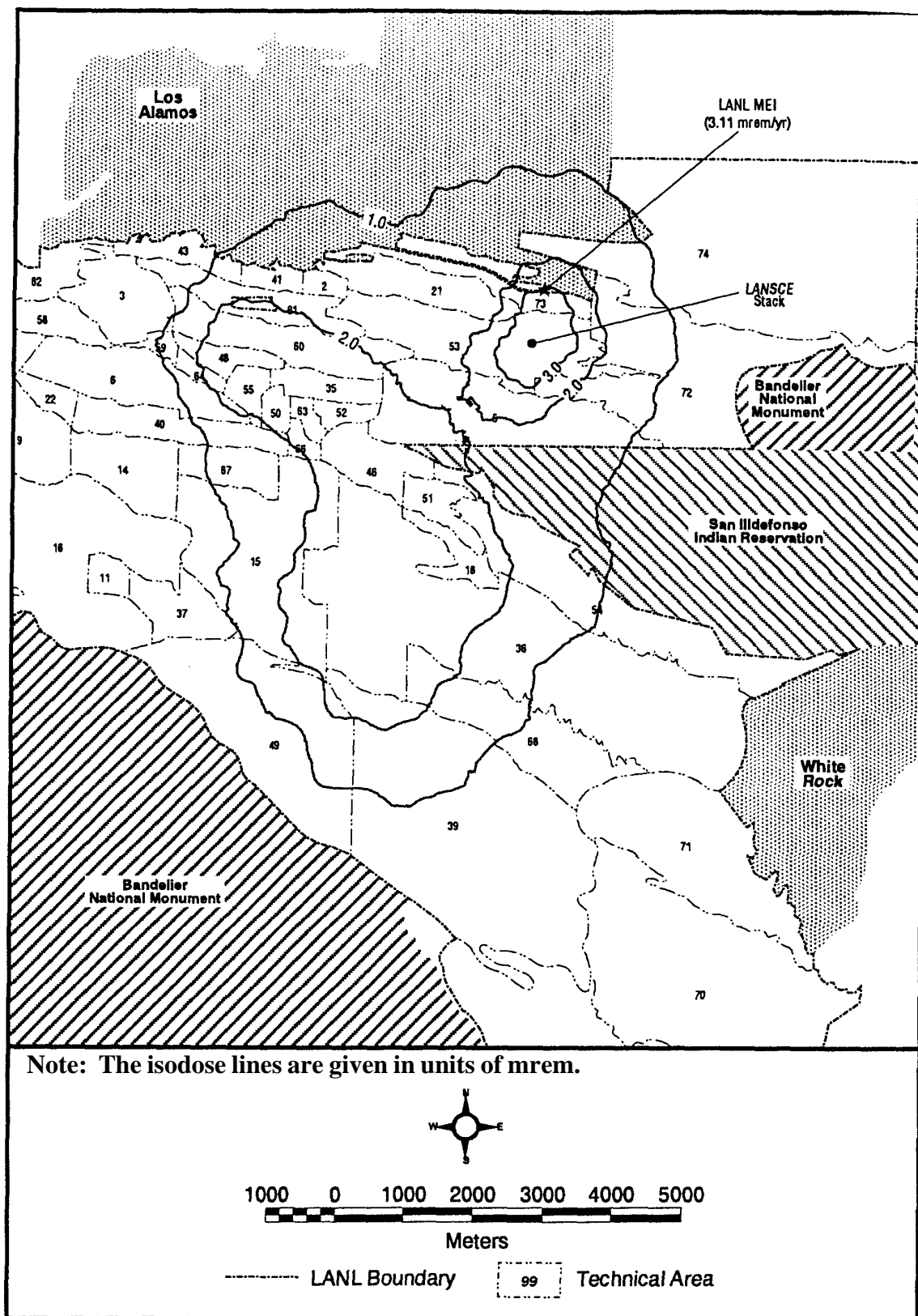


FIGURE B.1.2.4-1.—Annual Average Individual Doses Higher Than 1 Millirem per Year for the No Action Alternative.

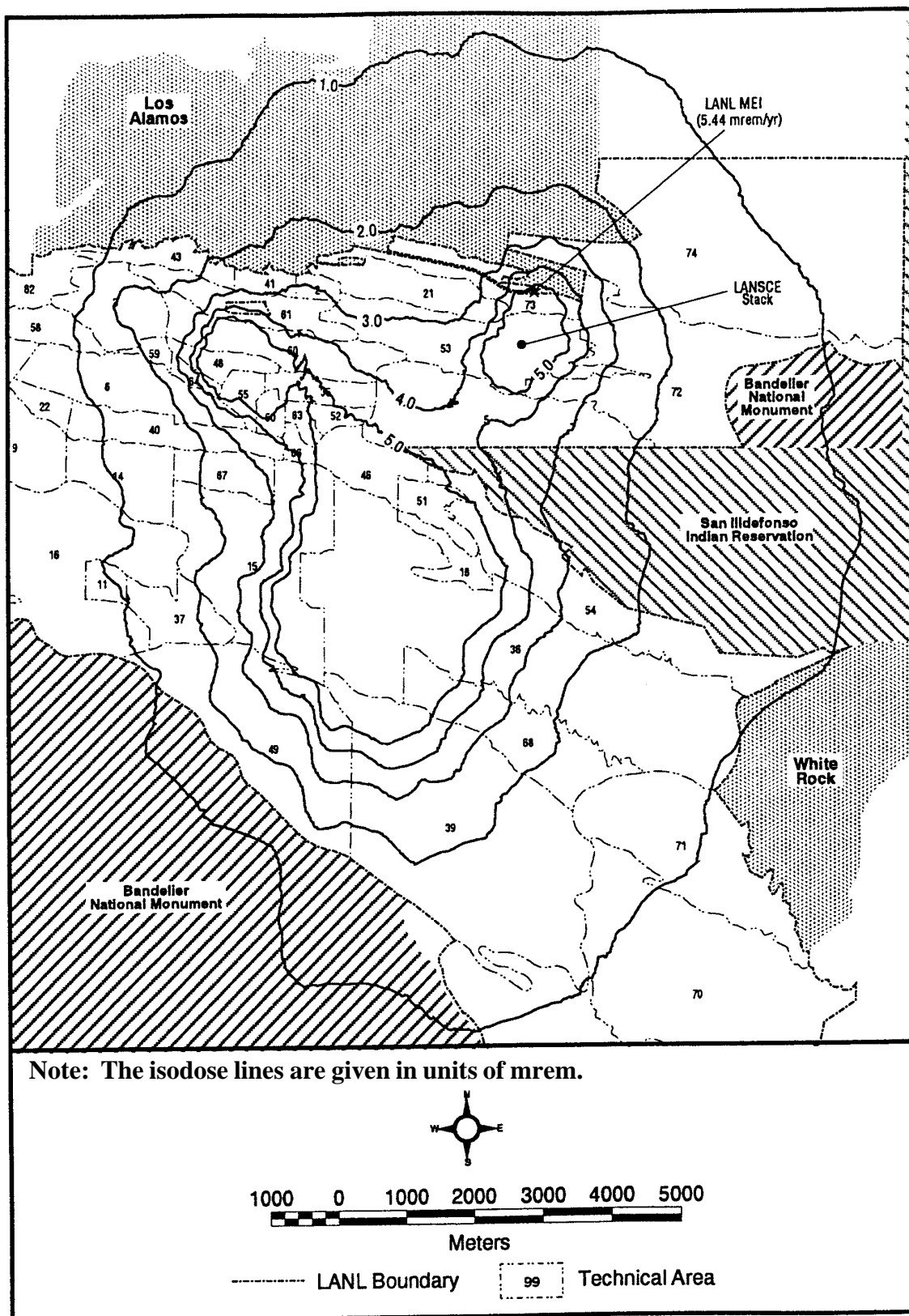


FIGURE B.1.2.4-2.—Annual Average Individual Doses Higher Than 1 Millirem per Year for the Expanded Operations Alternative.

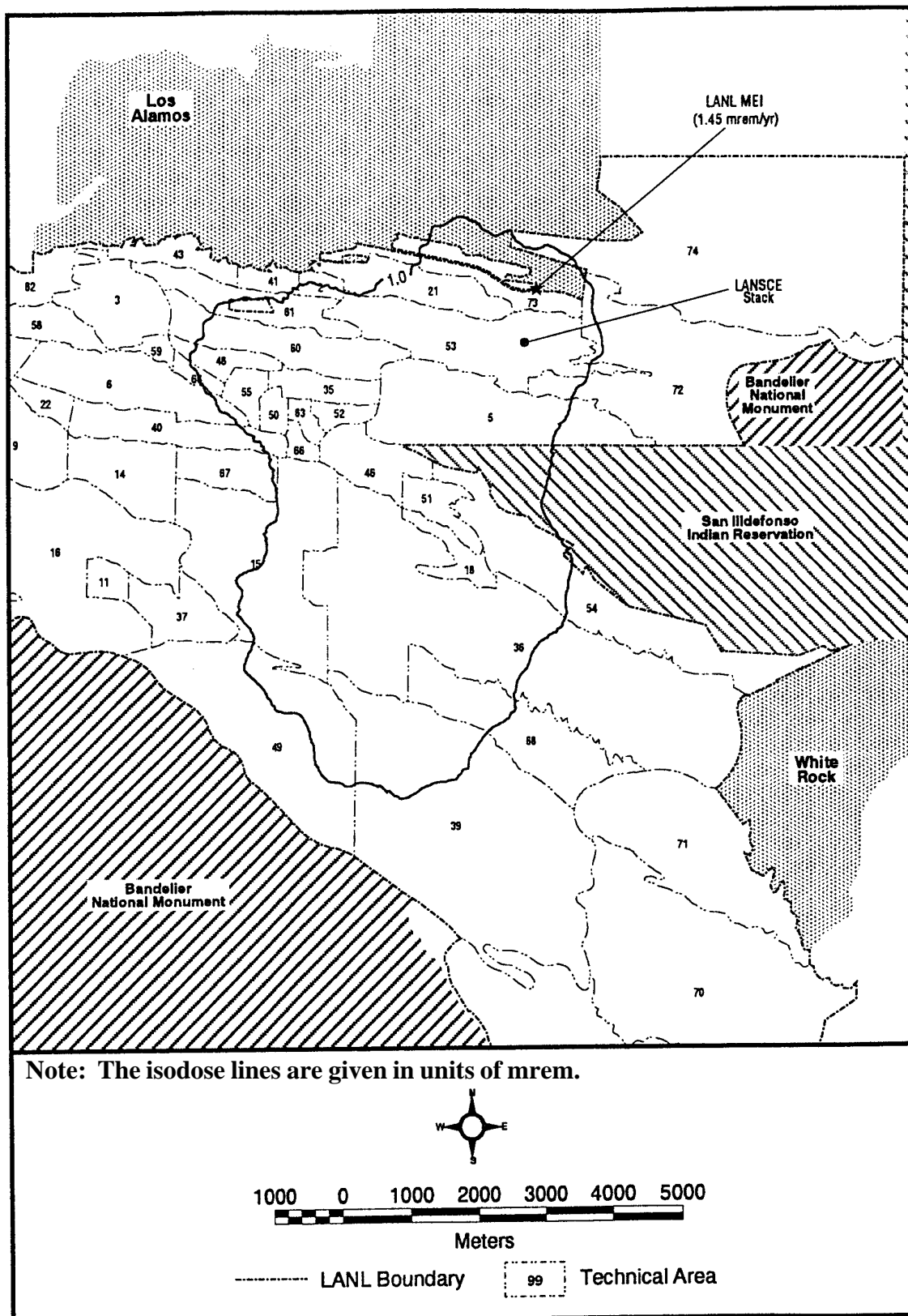


FIGURE B.1.2.4-3.—Annual Average Individual Doses Higher Than 1 Millirem per Year for the Reduced Operations Alternative.

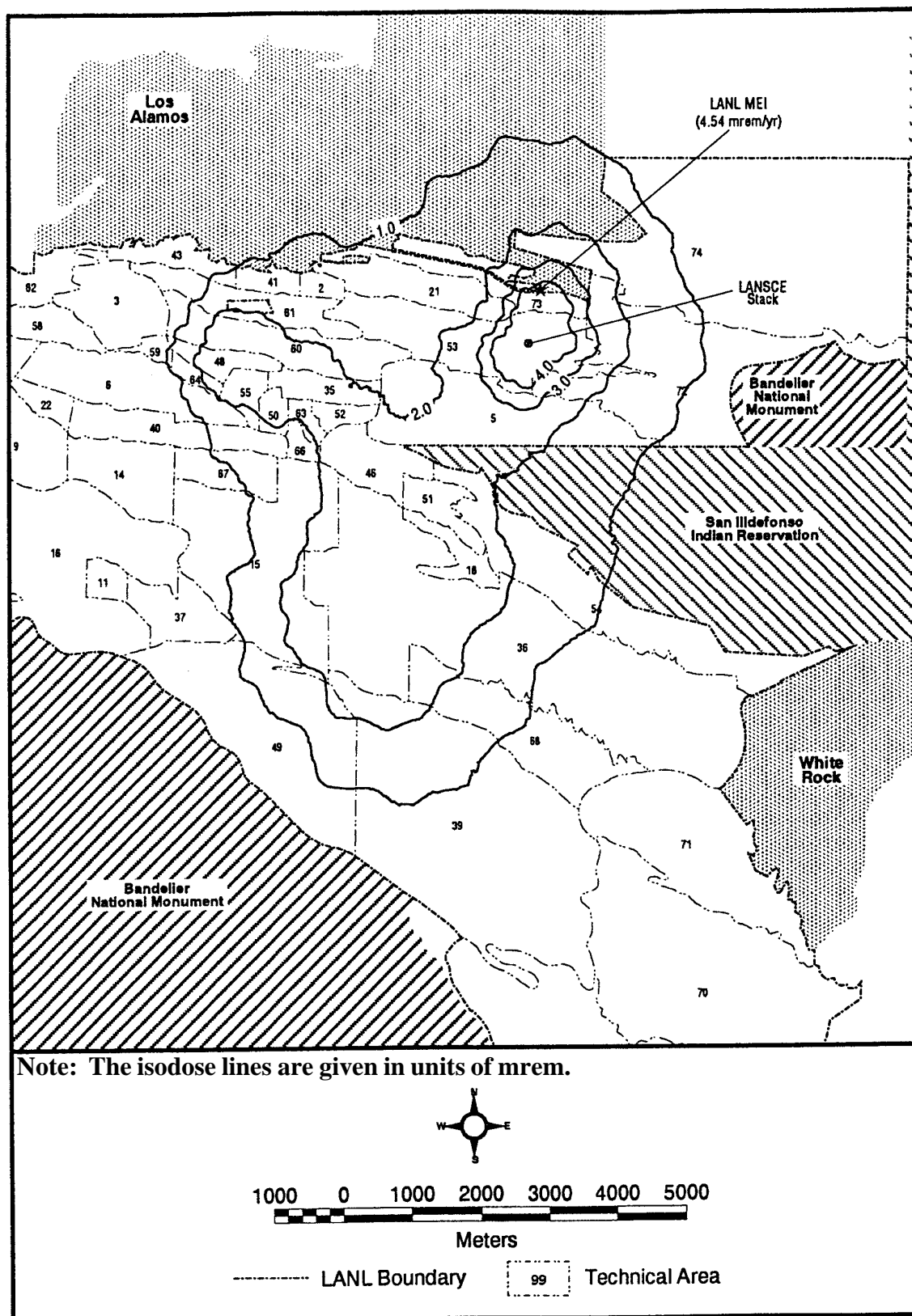


FIGURE B.1.2.4-4.—Annual Average Individual Doses Higher Than 1 Millirem per Year for the Greener Alternative.

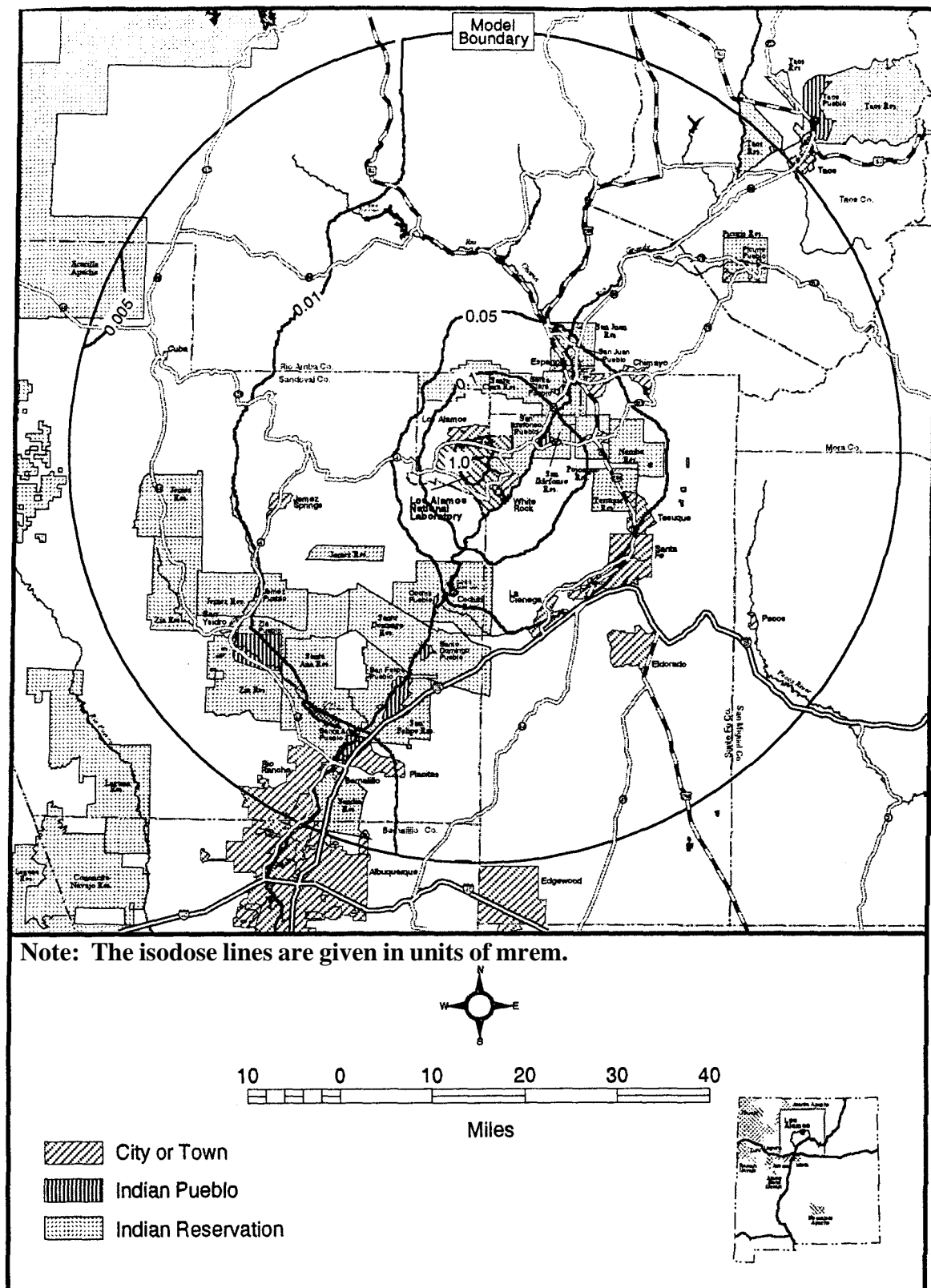


FIGURE B.1.2.4-5.—Annual Average Individual Doses Less Than 1 Millirem per Year for the No Action Alternative.

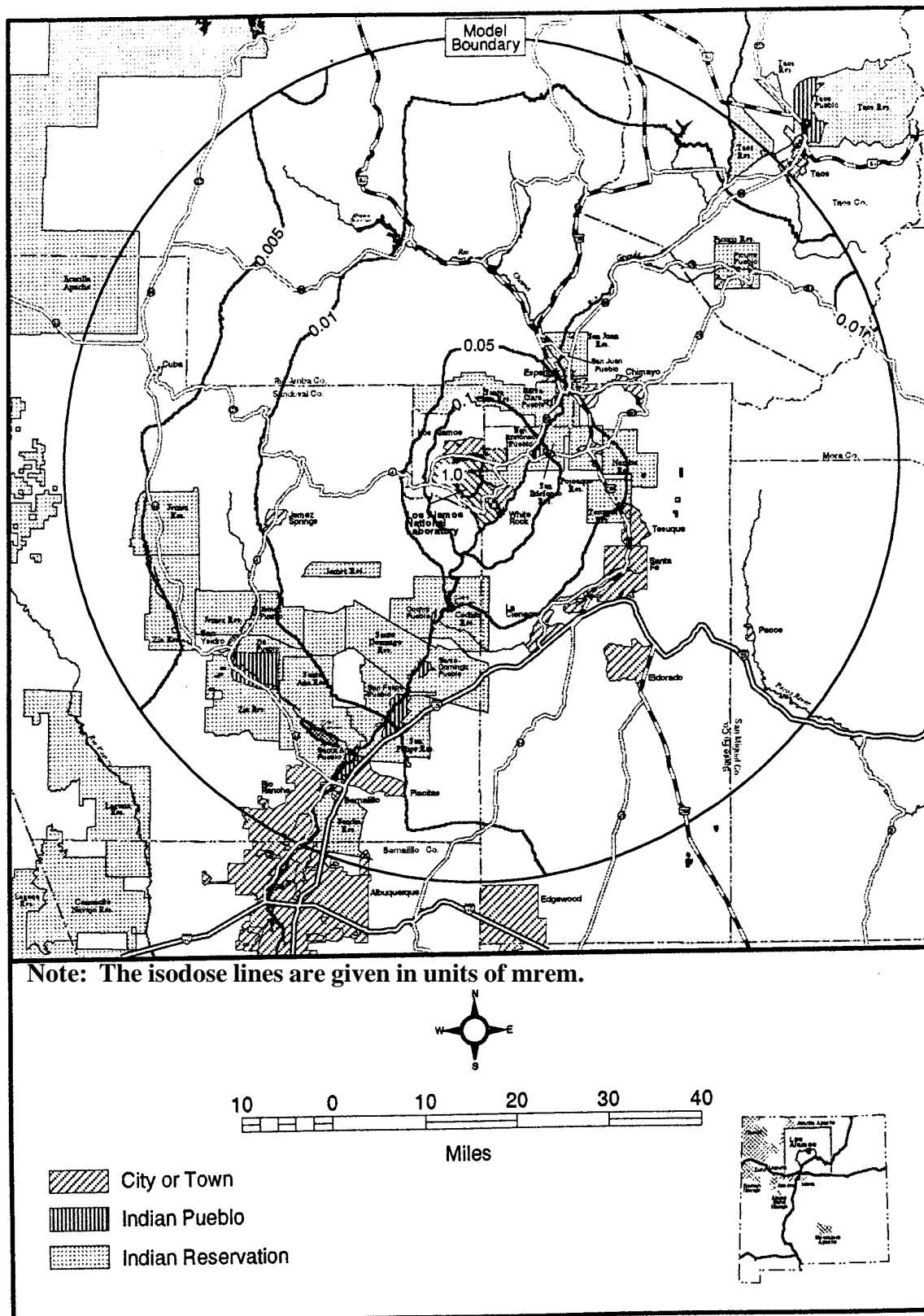


FIGURE B.1.2.4-7.—Annual Average Individual Doses Less Than 1 Millirem per Year for the Reduced Operations Alternative.

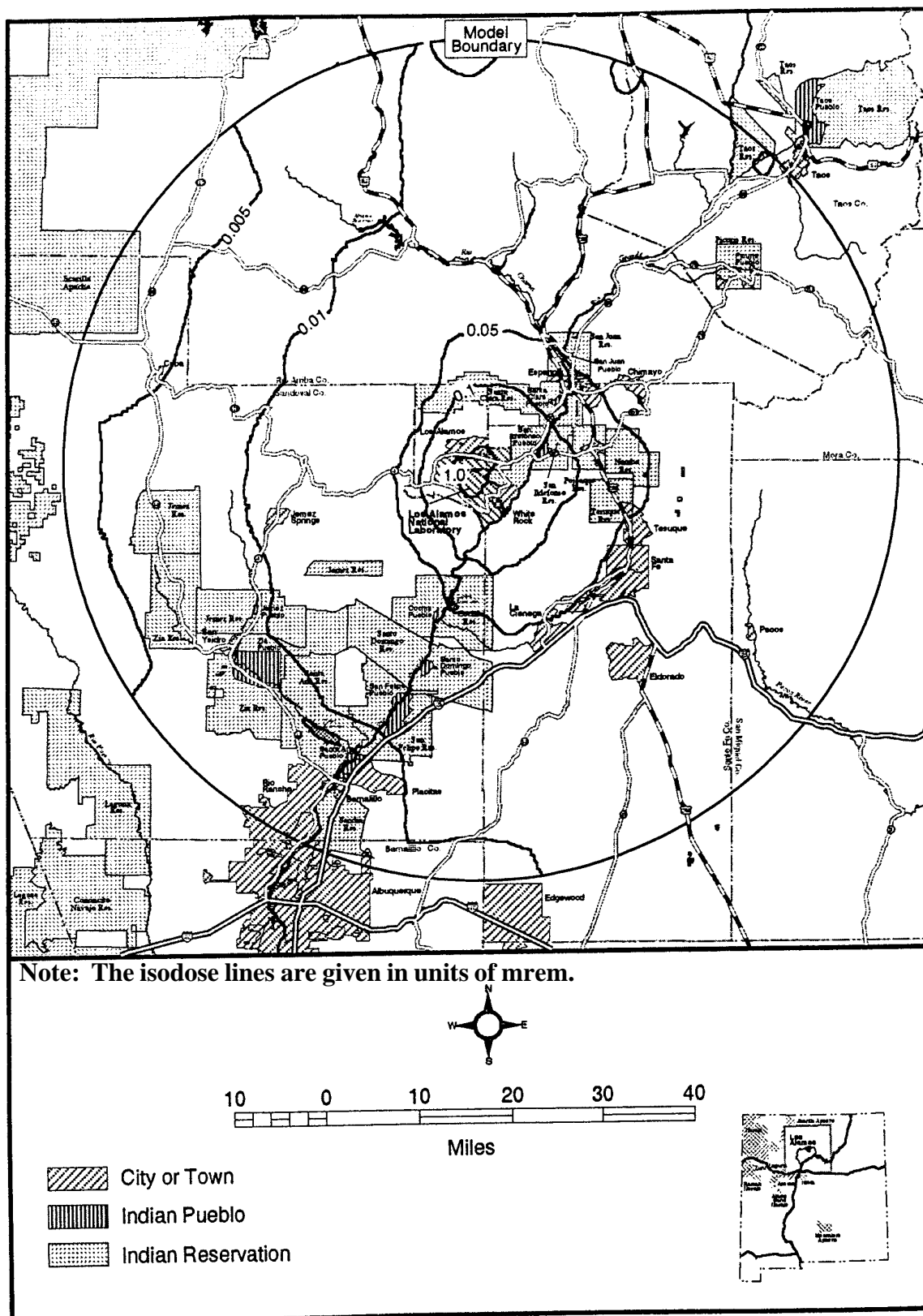


FIGURE B.1.2.4-8.—Annual Average Individual Doses Less Than 1 Millirem per Year for the Greener Alternative.

B.2 NONRADIOLOGICAL AIR QUALITY

The methodology description and the analysis results presented in chapter 5 are supplemented in this appendix with details on each aspect of modeling and analysis for criteria pollutants and toxic chemical emissions.

B.2.1 Assumptions, Data Sources, Standards, and Models

B.2.1.1 *Applicable Guidelines/Standards and Emission Sources*

Criteria Pollutants

The *Clean Air Act* mandates that the EPA establish primary and secondary National Ambient Air Quality Standards (NAAQS) for pollutants of concern nationwide. These pollutants, known as criteria pollutants, are carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, lead, and particulate matter smaller than 10 microns in aerodynamic size (PM₁₀). As of September 16, 1997, in addition to the PM₁₀ NAAQS, a new NAAQS became effective for particulate matter equal to or less than 2.5 microns (micrometers) in aerodynamic diameter (PM_{2.5}). These new standards will not require imposition of local area controls until 2005, and compliance determinations will not be required until 2008. Additionally, EPA revised the NAAQS and associated reference method for determining ozone attainment on July 18, 1997. This standard also will be applicable to LANL.

The State of New Mexico also has established ambient air quality standards for carbon monoxide, sulfur dioxide, total suspended particulates, hydrogen sulfide, and total reduced sulfur (New Mexico Administrative Code [NMAC], Title 20, Chapter 2, Part 3). State of New Mexico ambient air quality standards are

more restrictive than the national standards and are listed in attachment 1.

Criteria pollutants released into the atmosphere from LANL operations are emitted primarily from combustion facilities such as boilers, emergency generators, and motor vehicles.

Toxic Air Pollutants

Chemicals are currently used at LANL in separately located groups of operations or laboratory complexes (TAs) that are spread out over a large geographic area (43 square miles [11,140 hectares]). Toxic air pollutants from these TAs may be released into the atmosphere from many different ongoing activities, including laboratory, maintenance, and waste management operations. Two types of toxic air pollutants are considered in this analysis: noncarcinogenic and carcinogenic.

The two database information systems used primarily in this analysis are the 1995 Automatic Chemical Inventory System (ACIS) (LANL 1995a) purchase data and the Regulated Air Pollutants (RAP) Report data (LANL 1990).

ACIS is a listing of chemicals purchased at each LANL facility in each calendar year. The 1995 ACIS list identified more than 2,000 chemicals. This list was reduced to 382 chemicals by eliminating from consideration those that do not have adequate vapor pressure in a liquid state to be evaporated during chemical operations or have very low toxicity. Fifty-one of these 382 chemicals are considered by EPA to be carcinogenic. For the purpose of this analysis, it was assumed that air emissions could result from the use of any of the 382 chemicals from any of the 30 separate TAs that purchased these chemicals. A list of these chemicals is provided in attachment 2.

RAP is a LANL site-wide nonradiological air emissions inventory that was conducted at LANL in 1990. This inventory, however, was prepared more than 7 years ago when LANL

operations were significantly different from current operations. Because these data are not current, RAPS information was used in this analysis only to supplement ACIS data and other information gathered for this study.

Noncarcinogens. *Short-Term Guideline Values.* While no national or State of New Mexico standards have been established for noncarcinogens, the New Mexico Environment Department (NMED) has developed guideline values (GVs) for determining whether a new or modified source emitting a toxic air pollutant would be issued a construction permit (NMED/AQCRs, revised November 17, 1994). These GV's are 8-hour concentrations that are 1/100 of the Occupational Exposure Limits (OELs) established by the American Conference of Governmental Industrial Hygienists (ACGIH 1997) or the National Institute of Occupational Safety and Health (NIOSH). The State of New Mexico listing was supplemented with the most current information on the lowest values for OELs from these sources. These GV's were used in this analysis in screening for potential short-term impacts of toxic releases from LANL operations.

Annual Average Guideline Values. The GV's used in this analysis are the inhalation reference concentrations (RfCs) from EPA's Integrated Risk Information System (IRIS) (EPA 1993b). RfCs are daily exposure levels to the human population (including sensitive subgroups) during a lifetime (70 years) that could occur without appreciable risk of deleterious effects.

Carcinogens. The GV's used in this analysis to estimate potential impacts of carcinogenic toxic air pollutants from LANL operations are based on an incremental cancer risk of one in a million (1.0×10^{-6}) (i.e., one person in a million would develop cancer if exposed to this concentration over a lifetime), a level of concern established in the *Clean Air Act*.

This value was used in the screening for the estimated combined incremental cancer risk

associated with all of the carcinogenic pollutants emitted from LANL facilities at any location. For the purpose of screening individual carcinogens, a cancer risk of 1.0×10^{-8} was established as the GV.

B.2.1.2 Receptors and Receptor Sets

Two sets of receptors (i.e., locations where air quality levels were estimated) were considered for the analyses of criteria and toxic air pollutants.

- The first set of receptors includes nearby identified actual locations of human activity that might be affected from the emissions from LANL facilities. These include: (1) schools, hospitals, parks and playgrounds within Los Alamos; (2) residences (including those in trailer parks) in all directions surrounding all of LANL facilities in Los Alamos County; and (3) towns, cities, and sensitive national and cultural areas within approximately 50 miles (80 kilometers) of LANL. These receptors, which are listed in attachment 3, are referred to as sensitive receptors.
- The second set of receptors includes all of the closest off-site (i.e., fence line) locations (in 10-degree increments) around each TA to which the public could have access. These receptors are referred to as fence line receptors.

The potential impacts of air pollutants on workers employed at the LANL facilities were not considered as part of this analysis. Different regulations apply to an occupational setting, and the controlled nature of the work, along with surveillance systems associated with these controls, restricts routine exposures for workers. This analysis is focused on exposure to the public, and is based on a methodology that initially assumes that chemicals that are purchased are entirely available for release to the atmosphere outside the facility in which the chemicals are used.

Air quality standards have been established by the State of New Mexico for criteria pollutants for both short-term (i.e., 1-hour, 3-hour, 8-hour, and 24-hour) and long-term (e.g., 30-day, quarterly, and annual) time periods. In addition, GVs also were developed for toxic pollutants for both short-term (8-hour) and long-term (annual) time periods. Using these standards and GVs, the potential impacts of the pollutant emissions from LANL operations on these receptor sets were analyzed as discussed in the following paragraphs.

Criteria Pollutants

Short-term and long-term impacts for CO, NO₂, and SO₂, TSP, PM₁₀, and lead were estimated at the sensitive receptors, and the results were compared with applicable air quality standards. Both time frames were analyzed to address the potential short-term (acute) and long-term (chronic) impacts of these pollutants at locations where the public could have both short-term and long-term exposure to emissions from LANL facilities. Hydrogen sulfide and total reduced sulfur emissions are associated mostly with oil and gas industry; therefore, analysis for these pollutants was not necessary at LANL.

Short-term impacts also were analyzed at the fence line receptors surrounding TA-3, TA-16, and TA-21 in order to account for potential short-term exposure near the locations with relatively large combustion sources. The combustion sources at the other TAs are minor (primarily small boiler units and emergency generators) relative to the larger combustion units found at TA-3, TA-16, and TA-21, and are mostly for emergency back-up. The potential impacts at the fence line receptors of these minor sources were not considered.

Toxic Air Pollutants

Noncarcinogens. The potential short-term (acute) and long-term (chronic) impacts of these pollutants at locations where the public could

have both short-term and long-term exposure to emissions from LANL facilities were considered.

Short-term impacts were analyzed at the fence line receptors. Long-term impacts were not considered at these receptors because, although it is possible that the public could have access to fence line areas for short periods of time, the fence line locations are not places where visitors can freely walk around, nor is pedestrian traffic at these locations encouraged or actually encountered on a regular (long-term) basis.

Carcinogens. The annual impacts from the emissions of carcinogenic toxic air pollutants were analyzed at the sensitive receptors. Although GVs for short-term exposure were used in the screening steps, the more meaningful comparisons were to long-term GVs for sensitive receptors.

B.2.1.3 *Air Quality Dispersion Models*

The EPA's Industrial Source Complex Air Quality Dispersion Model (ISC-3) was used for both the criteria and toxic pollutant analyses. ISC-3 is a versatile model that is often used to predict pollutant concentrations from continuous point, area, volume, and open disposal cell sources (EPA 1992b). This versatile model is often preferred by the EPA because of the many features that enable the user to estimate concentrations from nearly any type of source emitting nonreactive pollutants.

EPA's PUFF model was used for a screening level analysis of emissions from LANL's High Explosives Firing Sites (HEFSs) at TA-14, TA-15, TA-36, TA-39, and TA-40. The PUFF model is designed to estimate downwind concentrations from instantaneous releases of pollutants (EPA 1992d).

The HOTSPOT code was used in combination with the ISC-3 model for a detailed analysis of

emissions from HEFF in order to provide a more readily usable input data file to the health effects analysis used in this SWEIS than provided by PUFF. The HOTSPOT code is designed for detonation of high explosives, and was used specifically to provide input data to the ISC-3 model (ORNL-LLNL 1996).

B.2.2 Criteria Pollutants—General Approach

The combustion sources that were evaluated in the analysis of criteria pollutants are listed in attachment 1. An atmospheric dispersion modeling analysis was conducted to estimate the combined potential air quality impacts of the emissions from each of these emission sources.

No quantitative analysis of vehicular-related emissions was performed as part of this analysis, but this emission source was included in the assumed background. Although the project alternatives may have different effects on the travel patterns in the study area as a result of changes in the number of LANL employees who would commute to Los Alamos, the future population of Los Alamos is expected to be the same under all of the alternatives. Therefore, the change in regional emissions under any of the future project alternatives are not expected to be more than a few (less than 5) percent. Because the study area is in attainment for the pollutants that are released primarily from motor vehicles (carbon monoxide and ozone precursors and nitrogen oxides [NO_x]) and because there are no nearby heavily congested traffic areas or major sources or ozone precursors (i.e., hydrocarbons and nitrogen oxides), no potentially significant air quality impacts are expected from the project alternatives.

B.2.2.1 Criteria Pollutants—Methodology

The analysis of combustion-related pollutants used standard analytical modeling techniques based on atmospheric dispersion modeling and emissions estimated under peak and actual annual average operating conditions of each major combustion unit. This information, together with stack locations and exhaust parameters (i.e., heights, diameters, flow rates), was available from LANL's air quality permit applications. Estimates of future emission rates were based on the operations anticipated under the Expanded Operations Alternative—the worst-case alternative with respect to emission rates from the combustion sources. These emissions were modeled using the ISC-3 model and meteorological data collected at TA-6. The methodology and procedures used are provided in attachment 1.

B.2.2.2 Results of Criteria Pollutant Analysis

The results of the analysis of criteria pollutants from LANL's combustion sources are presented in attachment 1. As shown, the highest estimated concentration of each pollutant is below the appropriate ambient air quality standard. None of the project alternatives, therefore, are predicted to significantly impact criteria pollutant levels.

B.2.3 Toxic Air Pollutants—General Approach

Unlike a production facility with well-defined operational processes and schedules, LANL is a research and development facility with great fluctuations in both the types of chemicals emitted and their emission rates. Because LANL's toxic air pollutant emission rates are relatively low (compared to releases from production facilities), vary greatly, are released

from hundreds of sources spread out over a large geographic area, and are well below the state's permitting threshold limits, toxic air pollutant emissions are not monitored. Current emission rates and stack parameter information necessary to conduct a conventional air quality analysis of the releases of toxic air pollutants are therefore not available.

An alternative approach was developed specifically for this analysis to estimate the potential air quality impacts of these pollutants. This approach is based on the use of screening level emission values (SLEVs). SLEVs are conservatively estimated hypothetical emission rates for each of the toxic air pollutants that could potentially be emitted from each of LANL's TAs and that would not result in air quality levels harmful to human health under current or future conditions. These SLEVs were compared with conservatively estimated pollutant emission rates on a TA-by-TA basis to determine potential air quality impacts of toxic air pollutants from LANL operations. This process consisted of the following steps:

- From over 2,000 chemical compounds listed as being used at LANL, 382 toxic air pollutants (including 51 carcinogens) were selected for consideration based on chemical properties, volatility, and toxicity.
- A methodology based on SLEVs was used to estimate the potential worst-case impacts of the toxic air pollutants. SLEVs for each chemical for each TA were compared with emission rates conservatively estimated from chemical use rates. If a conservatively estimated emission rate for a given pollutant from a given TA was less than SLEV, that pollutant emission source was deemed not to have the potential to cause significant air quality impacts, and, as such, no detailed analyses was required; if SLEV was less than the estimated emission rate for a given pollutant from a given TA, a more detailed analysis was conducted.

- An additive impact analysis was conducted to estimate the potential total impact from the emissions of each pollutant from more than one TA and the total incremental cancer risk from all of the carcinogenic pollutants combined at any of the sensitive receptor locations considered.

The methodology used in this analysis followed modeling guidelines for toxic pollutants established by the EPA (EPA 1988, EPA 1992c, EPA 1992e, and EPA 1992f) in that it first uses screening level evaluations based on conservative assumptions and resulting in maximum potential impacts, followed by more detailed analyses based on more realistic assumptions. The overall procedure used for this air quality assessment, including the development of SLEVs, is summarized in Figures B.2.3–1 and B.2.3–2. Also shown on these figures are the procedures used to compare SLEVs with the available emission data and the steps taken to evaluate the pollutants with potentially significant impacts. Each pollutant with the potentially significant impacts (as a result of the screening-level analyses) was subjected to progressively more detailed and more realistic evaluations.

B.2.3.1 Toxic Pollutants— Methodology for Individual Pollutants

Screening Level Analysis

Once SLEVs (both short-term and long-term) were established for each of the toxic air pollutants on a TA-specific basis (attachment 4, Methodology), a comparison was made between these values and conservatively estimated emission rates based on the Expanded Operations Alternative. A ratio was developed for each chemical by dividing the SLEV by the estimated emission rate (SLEV/Q).

These results, in the form of worksheets (an example for TA–3 is provided in attachment 5),

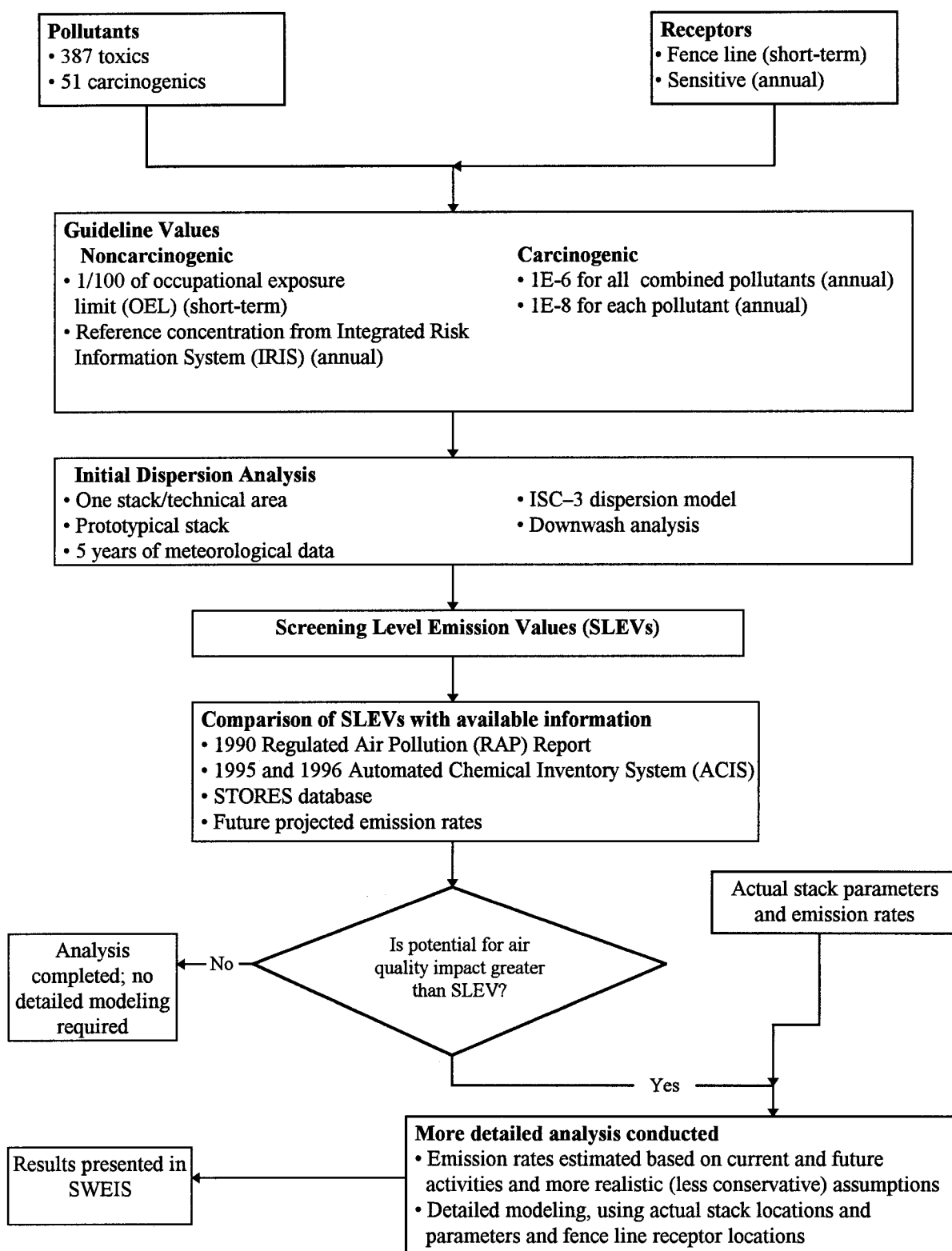


FIGURE B.2.3-1.—Process Used for Evaluating Toxic Air Pollutants.

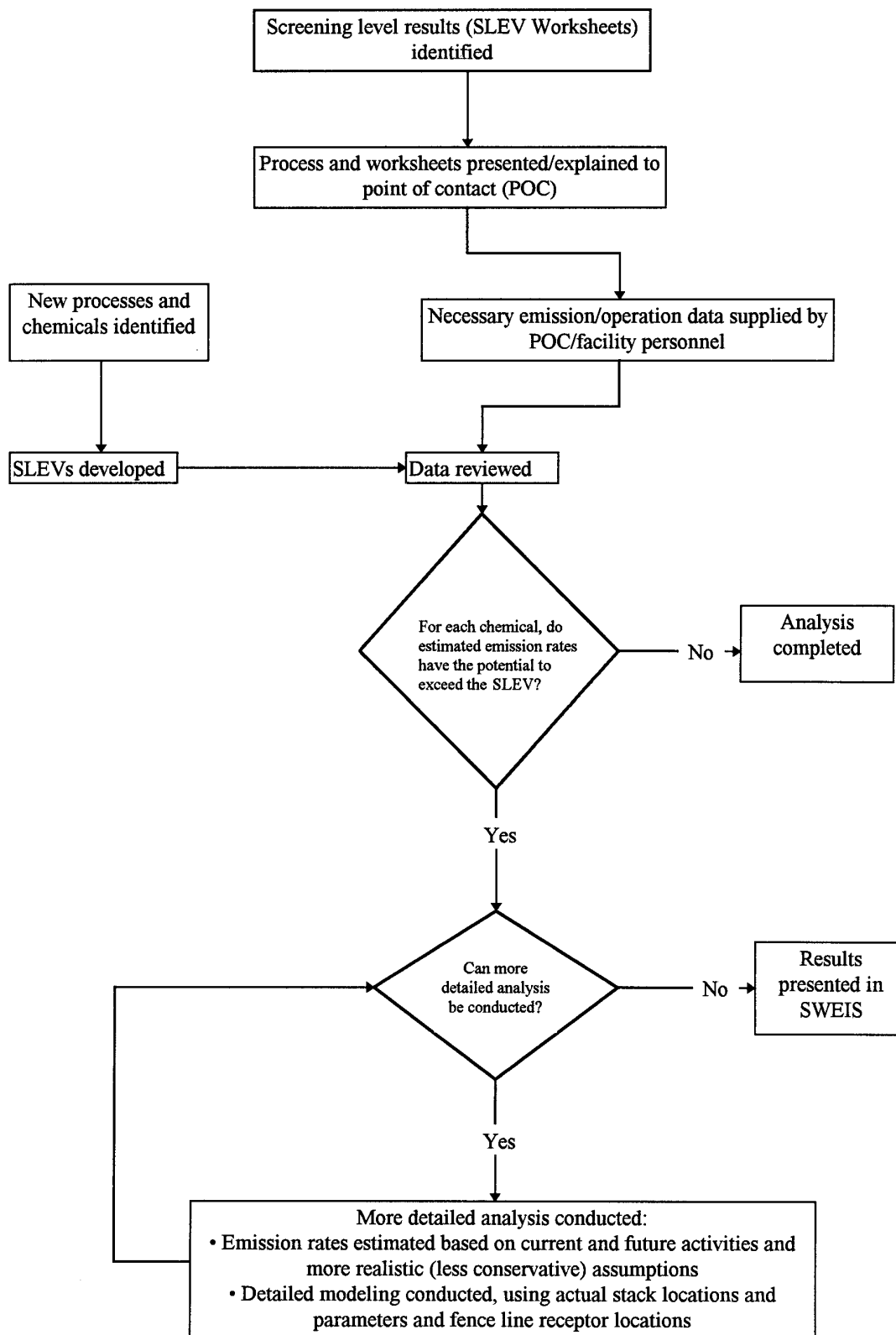


FIGURE B.2.3–2.—Procedures for Evaluating Potential Impacts of Toxic Air Pollutant Emissions from Each Technical Area.

were presented to knowledgeable site personnel who are aware of the activities and processes that are currently occurring at each TA as well as those that might occur in the future. In order to streamline the process, the relationship between SLEVs and the estimated emission rates for each TA were presented in two data sets.

The first data set included those chemicals with SLEV/Q ratios greater than 100. For each of these chemicals, a determination was made as to whether the utilization of that chemical would increase by more than one hundred times under future operation(s) of LANL under any of the project alternatives considered. Essentially, this meant that for each TA a determination had to be made as to whether the utilization of a chemical would increase over current use rates by a factor of 100. If a determination could be made that the future use of that chemical would not increase by this factor, no further evaluation of that chemical was required. If such a determination was not possible, a more detailed analysis was conducted.

The second data set included all the chemicals with a SLEV/Q ratio less than 100, and included those chemicals with a SLEV/Q ratio greater than 1 but less than 100, as well as those chemicals with a ratio less than 1. For each chemical with a ratio greater than 1 but less than 100, an evaluation was made as to whether the estimated emissions under any of the future alternatives would exceed the SLEV. Essentially, this meant that for each TA a determination had to be made as to whether the utilization of that chemical would increase over current use rates by a factor greater than the SLEV/Q ratio. If a determination could be made that the future use of that chemical would not increase by this factor, no further evaluation of that chemical was required. If such a determination was not possible, a more detailed analysis was conducted. For those chemicals with a SLEV/Q ratio less than 1 (i.e., SLEVs were potentially being exceeded under current

conditions), more detailed analyses were conducted.

Two exceptions to the details associated with this approach were made. Information on the TAs for high explosives operations were derived using a model more appropriate for screening short-term exposure concentrations under those conditions (attachment 13). The second involved screening the emissions of chemicals from The Health Research Laboratory (HRL) at TA-43. Because of the proximity of HRL to actual receptors, all analyses for carcinogens as well as noncarcinogens were performed for actual receptors rather than fence line receptors (attachment 14).

Detailed Analysis

The detailed air quality analysis consisted of one or both of the following steps:

- Development of emission rates and source terms parameters using actual process knowledge
- Dispersion modeling using actual stack parameters and receptor locations

Two consequences may result from the detailed analysis for each chemical from each TA: (1) either there is no potential to contravene a GV (in which case no additional analyses were required), or (2) there is a potential to contravene a GV (in which case additional analyses were required). A pollutant with the potential to contravene a GV was subject to evaluation in the health and ecological risk assessment process for this SWEIS.

B.2.3.2 *Results of the Toxic Pollutant Analysis— Individual Pollutants*

Screening Level

The first data set considered those chemicals with SLEV/Q ratios greater than 100. For more than 90 percent of the toxic air pollutants, a determination was made (based on current and proposed operations of the TAs) that the utilization of these chemicals would not increase by more than 100 times under any of the project alternatives. The second data set included chemicals with SLEV/Q ratios greater than 1 but less than 100, and ratios less than 1. A determination was made as to whether the utilization of that chemical would increase over current use rates by a factor greater than the SLEV/Q ratio. The list of carcinogens also was reduced from 51 to 35 because some of the chemicals are no longer used and are not projected for future use. Based on worksheets for the chemicals in these data sets, and information on potential future use, operations at 13 locations were identified with the potential to exceed a GV.

Detailed Analysis

Detailed analyses were conducted for the following emission sources:

- Methylene chloride emissions at TA-3 (attachment 7)
- Beryllium emissions at TA-3 (attachment 8)
- Nickel dust emissions at TA-3 (attachment 9)
- Paint booth (primarily volatile organic compound) emissions at TA-3 and TA-60 (attachment 10)
- Incinerator emissions (primarily metals and volatile organics) at TA-16 (attachment 11)
- Emissions (primarily volatile organic compounds) from open burning operations at the High Explosives Treatment and Disposal Facility at TA-16 (attachment 12)
- Emissions (primarily metals) from High Explosives Firing Site (HEFS) operations at TA-14, TA-15, TA-36, TA-39, and TA-40 (attachment 13)
- Emissions (primarily volatile organic compounds) from the Health Research Laboratory at TA-43 (attachment 14)
- Chloroform emissions at TA-53 (attachment 15)
- Beryllium emissions at TA-55 (attachment 16)
- Nitric and hydrochloric acid emissions at TA-55 (attachment 17)
- Nitric and hydrochloric acid emissions at TA-59 (attachment 18)
- Ozone Emissions at TA-53 (attachment 19)

Detailed Analyses—Results

Emissions from two sources were referred to the health and ecological risk analysis process. The analysis for TA-43 showed the potential to exceed the GVs for four chemical carcinogens from HRL: chloroform, trichloroethylene, formaldehyde, and acrylamide.

The detailed analysis for HEFF indicated that the same chemicals that had the potential to exceed a GV in the previous screening step, would also have the potential to exceed their respective GVs using somewhat different parameters and a different model than used in the screening analysis. A different model was used in the detailed analysis in order to provide output data in a form more readily usable for the health risk analysis. Additional information on the following chemicals was referred to the health and ecological risk assessment process for this SWEIS:

- Depleted uranium, beryllium, and lead from TA-15
- Depleted uranium, beryllium, and lead from TA-36

- Beryllium and lead from TA-39
- Depleted uranium and lead from TA-14

B.2.3.3 Toxic Pollutants— Methodology for Combined Impacts Analyses

The following analyses were conducted to ensure that the combined effects from the releases of all of the chemicals from all the TAs would not exceed the GVs.

Noncarcinogens

An analysis of potential short-term impacts at a TA's fence line receptors showed that the 8-hour impacts from the releases of that TA were significantly greater (i.e., more than two orders of magnitude) than the impacts from the releases of a nearby TA. This is because the TAs are relatively far apart in comparison to the distances between the emission sources of a TA and its fence line receptors. Therefore, it is unlikely that the additive short-term impacts of noncarcinogenic pollutants at the fence line receptors of a TA would be significantly different from the maximum concentrations previously estimated for that TA.

An analysis of annual potential impacts at sensitive receptors showed that these impacts were significantly less (i.e., less than two orders of magnitude) relative to the appropriate GVs than the corresponding short-term impacts at the fence line receptors. Therefore, it is unlikely that the additive annual impacts of the noncarcinogenic pollutants at the sensitive receptors would be significant.

Carcinogens

Two different versions of additive impacts for carcinogens are presented. Both consider impacts at sensitive receptors based on annual ambient concentrations of pollutants. Short-term additive impacts for carcinogens at fence line receptors were not considered for the same

reasons as for noncarcinogens. However, long-term impacts at sensitive receptors were considered because EPA considers in their standard setting process that risk from carcinogens can be additive for all carcinogenic chemicals.

The first version considered whether emissions of the same chemical from all TAs (whether or not it was actually used at that TA), at the SLEV rate (whether or not that maximum rate was actually projected at that TA) would exceed the total guideline risk value of 1×10^{-6} . The risk due to exposure at the maximum concentration over a lifetime for any receptor for each of the TAs was added to the separately calculated maximum concentration for any receptor for each of the other TAs, regardless of whether the same receptor was indicated.

The second version modeled simultaneous emissions of the same chemical at actual projected rates for each of the TAs, and recorded the maximum concentration at any receptor location. The risk due to exposure at that concentration over a lifetime was then added to the risks calculated in a similar fashion for each of the other chemicals. Risks were added regardless of whether or not the same receptor was involved. That total risk was also compared to the guideline risk value of 1×10^{-6} of any excess cancer from a lifetime of exposure.

B.2.3.4 Toxic Pollutants—Results of Combined Impact Analysis

Releases of Each Carcinogenic Pollutant from All TAs

The estimated combined cancer risk associated with releases of each of these pollutants from all TAs is 1.23×10^{-7} , which is below the GV of 1.0×10^{-6} . As such, no potentially significant air quality impacts were estimated.

Releases of All Carcinogenic Pollutants from All TAs

Results of this analysis are presented in attachment 6. As shown, the potential combined incremental cancer risk associated with releases of all carcinogenic pollutants from all TAs is slightly above the GV of 1.0×10^{-6} .

The major contributors to the estimated combined cancer risk values are chloroform, formaldehyde, and trichloroethylene from HRL at TA-43 and multiple sources for methylene chloride. The estimated maximum cancer risk for each of these individual pollutants is 8.74×10^{-7} , 5.17×10^{-8} , 6.73×10^{-8} , and 6.84×10^{-8} , respectively. Of these, the relative contribution of chloroform emissions alone to the combined cancer risk value is more than 87 percent. The impacts of TA-43 emissions are due to a combination of relatively high emission rates, close proximity between receptors and sources, and the elevation of the receptors.

Because the result of this analysis was slightly above the specified GV of 1.0×10^{-6} and a

simplifying but conservative approach was used that added the maximum risk from each chemical even though different receptors may have been involved, a more detailed analysis that considered the impact at each specific receptor location was conducted. This more refined analysis estimated the combined cancer risk at each of the 180 sensitive receptor locations.

As shown in attachment 6, the combined incremental cancer risks associated with releases of all carcinogenic pollutants from all TAs at the receptor locations where these impacts actually occur are slightly above the GV of 1.0×10^{-6} at the two locations within the LANL medical center: 1.17×10^{-6} at a receptor in an air intake duct and 1.07×10^{-6} at an operable window. Because the estimated cancer risk at these two receptor locations is slightly above the GV of 1.0×10^{-6} , these results were referred to the health and ecological risk assessment processes for this SWEIS.